

THE RELATIONSHIP OF SELECTED MEASURES OF
APTITUDE, INTEREST, AND PERSONALITY TO
ACADEMIC ACHIEVEMENT IN ENGINEERING
AND ENGINEERING TECHNOLOGY

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in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
July, 1968

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PREFACE

Recent societal pressures have focused attention upon the need to identify the characteristics of successful engineering and engineering technology students. Much research has been conducted in the past concerning factors associated with success in professional engineering, with limited regard for the systematic identification of characteristics related to success at the semi-professional level. With the associate degree engineering technicians representing one of the most rapidly expanding areas of the engineering occupations the problem of identifying and better understanding the characteristics of successful candidates has had a corresponding expansion. The principle aim of this study was to determine if certain measures of aptitude, interest, and personality were related to academic success in engineering and engineering technology.

I would like to express my appreciation to Dr. Harry K. Brobst, doctoral committee chairman, to whom I am indebted for his generosity and thoughtfulness as the adviser for the doctoral program and for his excellent guidance and advice as director of the dissertation. Appreciation also is expressed to committee members Dr. Dale Grosvenor, Dr. Charles Larsen, and Dr. Norman Wilson for their encouragement and assistance in executing this manuscript. Appreciation is expressed to Dr. David Shoemaker for assistance in evaluating, analyzing, and programing the data.

Indebtedness is acknowledged to Donald Brown, Edwin Darby, Lester Hunter, Eugene Mouser, and John O'Toole, all of Oklahoma State University, for their assistance in obtaining the data used in this study.

To my wife, Mary Ellen, and my son Bradley, my deepest appreciation for their patience, encouragement, and understanding during the entire time spent in achieving the doctoral degree.

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CHAPTER I

THE NATURE OF THE PROBLEM

Introduction

In recent years, the needs of the Nation's defense and space programs, added to those of an expanding and increasingly technical economy, have greatly intensified the need not only for engineers but also for the trained technicians who assist them. While considerable research has been conducted in the past to identify the characteristics of successful professional engineering students, limited systematic study of the individuals who enter the semi-professional levels has been done. With the associate degree engineering technicians representing one of the most rapidly expanding occupational groups, the problem of identifying and better understanding the characteristics of successful candidates has had a parallel expansion. Perrone (42) has recognized the need for additional trained technicians and has pointed out the need for further research:

High school age youth and school counselors are unaware of the characteristics of individuals who enter and successfully complete a technical training program Unless more is known about the job itself and the people who work as technicians, the need will continue to exist while a manpower surplus will remain. (p. 137)

Purpose of the Study

This investigation was concerned with three groups of freshman

male students who entered different educational institutions administered by the College of Engineering of Oklahoma State University.

Group I consisted of on-campus engineering students; Group II consisted of on-campus technical institute students; and Group III consisted of metropolitan technical institute students.

More directly, the purposes of this investigation were (1) to examine the differences in certain measured intellectual and non-intellectual characteristics between on-campus engineering freshmen, on-campus technical institute freshmen, and metropolitan technical institute freshmen, (2) to determine if there are significant differences in the tested characteristics between satisfactorily achieving and low achieving engineering and engineering technology students, and (3) to study the relationships between the measured characteristics and achievement in the engineering and technical institute programs.

Need for the Study

The need for identifying characteristics such as aptitudes, reading skills, mathematical skills, interests, and personality variables which might be related to success within the engineering technician curriculum is clearly evident when the distinct nature of technical institute education is considered. The curriculum must be designed to provide basic scientific and mathematical skills similar in some respects to those required of the engineer and training in manipulative skills as those required of the tradesman or skilled worker. However, in contrast to trade and vocational education, which is directed primarily toward developing rather specific

manipulative skills, the objective of manipulative training in technical institute education is to enable the student to apply scientific and technical knowledge to particular technical problems. At the other extreme, technical institute education must be distinguished from engineering education which leads to a baccalaureate degree and includes a curriculum content much more heavily weighted toward theory than application. Thus, although there are some similarities, the educational program for the engineering technician differs from that of the engineer and from that of the tradesman. A testing program which may be useful for predicting the success of vocational students, engineering students, or other college students pursuing a baccalaureate degree may not be dependable for predicting the success of students in technical institute programs. Hoyt (31) has recognized this problem and has further asserted that:

A priori logic suggests that students who enroll in such curriculum might be quite different from those who enroll in other types of college programs. They might be expected to be less able intellectually and less academically motivated than aspirants to a four-year degree. For these reasons and others their performance in academic work may be more difficult to predict on the basis of traditional measures (standardized academic ability tests and high school grades). (pp. 22-23)

Further need for research within the professional and semi-professional levels of engineering education is seen in recent reports and surveys concerning trained manpower requirements. A recent estimate by the U. S. Bureau of Labor Statistics (58) indicated that the demand for new engineering technicians for the period of 1963-1975 will range from 892,000 to 1,237,000, depending upon economic conditions during those years. This report also estimated that the supply of technicians with formal training will range from 475,000 to

1,040,000 during this period.

The additional requirements for technicians in Oklahoma has been projected to be 11,662 and 18,830 in 1970 and 1975 respectively (38).

The Oklahoma Regents for Higher Education (39) have recognized this need and have acknowledged the significance to public education:

The demands for technical and vocational education will skyrocket over the next decade, according to all available indexes; consequently, Oklahoma will need to expand its capabilities in these important areas at the post-high school level. The number of technical workers needed for Oklahoma in 1975 is projected to be approximately 50 to 60 percent greater than the 35,000 workers in the technical category who were counted in a 1963 man-power survey A great majority of these will have to be trained in post-high school institutions; therefore, Oklahoma colleges of the two-year type will need to begin planning programs to prepare these and other kinds of technicians. (pp. 66-67)

Along with the anticipated growth in demand for engineering technicians, the need for professional engineering graduates is also projected to increase in the late 1960's and early 1970's. Despite increases in the number of engineering graduates at all academic levels, the supply is expected to fall short of demand (57). The Engineering Manpower Commission (16) has indicated that the average annual demand for graduate engineers will be approximately 72,000 graduates per year for the next decade. This contrasts with the present rate of 34,700 professional engineering graduates per year.

The problem of personnel needs in the engineering and kindred occupations is related not only to better understanding the characteristics of students who enter various training curricular, but also to how well students persevere and achieve within the related programs. In a survey of 91 technical institutes, Henninger (27) found that the median percentage of students who completed the institute program was 50 per cent. Righthand (45) reported a dropout rate of

about 40 per cent of his sample of engineering technician students. Metz (34) has reported that during the past few years the national dropout average for technical institute students has been approximately 30 per cent. In short, apparently about four out of every ten of the youth entering engineering technician training have not completed their program for one reason or another. Concomitantly, recent reports have indicated that the national dropout average for students in baccalaureate degree engineering programs is approximately 50 per cent (16). These attrition rates represent a real loss, both financial and societal. Society's loss may be expressed by an increasing gap between the demand for engineer and technician services and the short supply of available personnel.

Additional incentive for this study was generated by the need for more adequate information for use in vocational guidance. Harrington (26) has stated this problem:

Information relevant to vocational guidance in this area is virtually nonexistent. In light of the fact most technical institutes have admission standards comparable to requirements for four-year institutions, psychological data are needed which will enable counselor and client to review the alternatives of further education on a sound basis. (p. 401)

Righthand (45) has stated that secondary school counselors have found very little data that provide insight into the characteristics of the type student attending the technical institute or in the factors leading to successful achievement in an institute program. Student personnel workers in the technical institutes face the same problem in working with their counselees. Similar views have recently been expressed by Metz (34), Hoyt (31) and Perrone (42). It was hoped that the information provided by this study would be useful to counse-

lors and students in differential guidance and decision making. Also, it was expected that this study would provide information which would be useful in the planning of additional research in this area.

Limitations of the Study

This study was limited to three groups of freshmen students enrolled for the first time in the College of Engineering, Oklahoma State University, during the 1967 fall semester. Only full-time male students who had completed no extended training other than high school were included. Students who had transferred into the College of Engineering as freshmen with fifteen or more hours of previous college credit were excluded from this study.

The criterion of achievement in each of the three groups was limited to the grade-point average received at the end of the first fall semester in school. Success in nearly every engineering and technical institute program depends upon knowledge and skills developed in a structured sequence of subjects. If the student has not done satisfactory work in the basic semester, he is unlikely to succeed in the next important subjects.

There have been a few studies reported in which grade-point averages in the first quarter or semester were used to predict overall academic success in the engineering school. Higgins (29) at Cornell University predicted students' average grade for four years in the School of Engineering from the combined grade average in two required courses for freshman engineering students. The r was .84.

Pierson (44), as a result of a detailed study of engineering students at the University of Utah, concluded that the freshman year

is the crucial one and that the first quarter is nearly as good a predictor as the total grade-point average for the first year.

Siemans (48) attempted to determine how well success in upper division engineering courses could be predicted. The grade-point average for the first semester was used as the predictive device and the grade-point average in all the upper division courses was chosen as the criterion. There was a coefficient of correlation of .87 between these two variables. Although other combinations of predictor variables were compared, total grade-point average at the end of the first semester was the best predictor of success in the four-year engineering program.

Past records at Oklahoma State University indicate that the freshman year is the most critical in both the technical institute and the professional engineering programs (35).

Underlying Assumptions of the Study

A major assumption underlying this study was that a limited number of basic trait measurements will be adequately associated with success as herein defined. It has been stated by Horst (30) that for reasons of parsimony, the number of fundamental measures used in the selection process should be as small as possible and each one should be significantly related to only a few criteria.

A second underlying assumption in this study was that of the population of students entering the training program on a no-prior-selection basis, some will tend to achieve while others will tend to be unsuccessful. More precisely, the tendency to achieve or not to achieve was assumed to be evenly distributed within the populations

investigated.

The third major assumption underlying this study was that all students enrolled in the various engineering and technical institute programs were exposed to comparable conditions. While institutional factors such as student-teacher rapport, teacher grading criteria, and quality of instruction are manifestly important, they were considered as random variables in this study.

Definition of Terms

Within the structure and limitations of this dissertation, the following terms are utilized as defined. A description of the subjects and instruments employed in this study is presented in Chapter III.

Satisfactorily Achieving refers to those students who had a grade-point average of 2.00 or better at the end of the first fall semester in school. The grading system used in the College of Engineering is as follows: A-4.00; B-3.00; C-2.00; D-1.00; F-0.00. A student is required to obtain a minimum grade-point average of 2.00 to meet graduation requirements.

Low Achieving refers to those students who had a grade-point average of 1.99 or below at the end of the first fall semester in school.

On-Campus Engineering. This refers to the professional engineering school located on the Oklahoma State University campus at Stillwater. In the College of Engineering the Bachelor of Science degree can be earned in the following branches of engineering: Agriculture, Chemical, Civil, Electrical, General, Industrial, Mechanical,

Petroleum, and Aerospace. All curriculums are based upon the principle of stressing fundamental training in mathematics, the basic sciences, and English during the first two years. Instruction in the specific fields of engineering is offered during the junior and senior years. The enrollment consists primarily of residential, full-time students.

On-Campus Technical Institute. This refers to the technical institute located on the Oklahoma State University campus at Stillwater. The on-campus institute offers the associate degree in the following areas: Aeronautical, Construction, Drafting and Design, Electronics, Fire Protection, Mechanical, Metals, Petroleum, and Radiation and Nuclear Technologies. The enrollment consists primarily of residential, full-time students.

Metropolitan Technical Institute. This refers to the Oklahoma State University Technical Institute located at Oklahoma City. The metropolitan institute offers the following associate degree programs: Architectural and Structural Drafting and Design, Civil, Computer Programming, Industrial Drafting, Electronics, and Instrumental and Process Control Technologies. This institute does not provide dormitory facilities and each student is responsible for making his living arrangements. The enrollment consists of full-time and part-time students attending both daytime and evening classes. The majority are part-time and evening students.

Both of the technical institutes are administered as part of the Oklahoma State University College of Engineering and both offer two-year, college-level specialized programs leading to an Associate in Technology degree. The structure and content of the curriculums at the two institutions are very similar. In general, 64 per cent of

each curriculum consists of specialized technical courses, 15 per cent is devoted to mathematics, 6 per cent consists of science courses, and 15 per cent is devoted to general education courses (43).

CHAPTER II

A REVIEW OF RELATED LITERATURE

In this chapter selected studies pertinent to the thesis of this investigation are discussed and summarized. Most of the studies reported herein were concerned with the significance of aptitude, achievement, interest, and personality variables related to the academic achievement of technical institute students and engineering students.

Studies of Technical Institute Students

Research specifically pointed toward identification of factors significantly related to the academic success of technical education students has been limited in the past, but with the increasing societal demand and the ascending role of the technician, a small increase in studies was noted. However, the number of investigations has remained small and almost all of those reported are localized and limited in scope.

Righthand (45) used a population of 263 freshmen attending two public technical institutes in Connecticut to study differences between dropouts and survivors. The instruments used to measure the characteristics of these students were the Engineering and Physical Science Aptitude Test (EPSAT), the Study of Values, the Hermon-Nelson Test of Mental Maturity, and the Survey of Study Habits and Attitudes.

The mathematics portions of the EPSAT and the score on the Survey of Study Habits and Attitudes were ranked as the two most significant factors in discriminating the attrition members from the survival group. The quantitative score of the Henmon-Nelson was found to rank third in discriminatory effectiveness.

Greenwood (23) studied factors that might predict success in three technical institute curriculums. He found that most failures were attributable to more than one factor. He also found that mathematics played a significant role in success, and the Engineering and Physical Science Aptitude Test was a useful predictor of success in one institution.

Halsey (25) obtained a multiple correlation of .60 between the first-year averages of students who entered various technical curriculums of a community college, and a combination of high school index (an average of high school marks in elementary algebra, general science, American history, and third-year English), Differential Aptitude test (DAT) Numerical score, DAT sentences score, and DAT Mechanical Reasoning score.

Brown (6) investigated the relationship between the first-year grade-point average of technical institute students and scores on the American College Testing Program, the Differential Aptitude Test, and the Nelson-Denny Reading Test. He obtained the following correlations with individual predictions: ACT Composite, .41; DAT Mechanical Reasoning, .33; DAT Spatial Relations, .07; and Nelson-Denny Composite, .33. When independent correlations were determined for the subtests of the ACT, DAT, and Nelson-Denny, he found that reading vocabulary was the single best predictor of success.

Shigetomi (47) found that the Verbal Reasoning and Numerical Ability sections of the Differential Aptitude Test Battery had a significant relationship with the grade-point average of students enrolled in electronics technology.

Perrone (42) used a sample of 20 electronics students and 16 design students to study the relationship between scores on the General Aptitude Test Battery (GATB) and grade-point average in technical subjects. Though not statistically significant, he found a relationship in a positive direction between grade-point average and GATB scores for design students. This same relationship had a negative direction for electronics students.

Herman and Zeigler (28) reported a study in which they used the Pennsylvania State University Academic Aptitude Examination and the Strong Vocational Interest Blank to make a comparison between two-year technical institute students and four-year engineering students. When members of each curriculum were categorized according to grade-point average of two or above (high achievers), grade-point average below two (low achievers), and withdrawal from the University, it was found that the lowest mean scores in ability tests obtained by an engineering subgroup exceeded the highest mean score obtained by any technical institute subgroup. Although no correlations were reported, success within a curriculum and ability scores seemed to be directly related. When interests were considered according to the three categorizations, it was found that interests and degree of success seemed to be more related than interests and curriculum. The high achievers in both curriculums generally exhibited stronger interests in engineering and chemistry than did either the low achievers or the withdrawals.

Miller (35), using a sample of 50 engineering students and 84 technology students, conducted a study to identify psychological and social measures related to successful completion of the freshman year of study in a four-year engineering program compared with a two-year technical institute program. He found that the engineering freshmen came from significantly higher social class backgrounds, had significantly higher scholastic aptitude, and had greater ability to visualize spatial relationships than technicians. The engineers were found to have a more theoretical orientation, more motivation for achievement, and a significantly higher need to dominate than the technicians. The technicians demonstrated a greater need for nurturance than did the engineers.

When the students from the two curriculums were combined, Miller's analysis indicated that the non-dropouts had significantly higher scholastic aptitudes, motivation to achieve, and higher economic needs orientation than the dropouts. The dropout group had significantly higher scores for affiliation and nurturance than the non-dropouts.

Hoyt (31) used a sample of 834 students from six colleges to study the usefulness of the American College Testing Program (ACT) in predicting grades in two-year, terminal, vocationally-oriented curriculum. He concluded that:

1. The academic potentials of the six groups were remarkably homogeneous. This was more true when potential was measured by high school grades than when it was measured by ACT scores.
2. These potentials were well below the average established for all colleges, but only slightly below the general junior college average. They were weaker in English and social studies than in mathematics and natural sciences.
3. College grades for these students averaged slightly

higher than comparable grades for all college students and for all junior college students.

4. ACT scores and high school grades were about equally predictive of college grades. Combined they possessed useful predictive validity for these "non-academically" oriented students. The level of predictability was, however, reduced over that typically obtained from such data. (p. 23)

Studies of Engineering Students

Research with engineering students has been widespread over the past few years, and a selected number of studies whose results bring into focus what seems to be some of the most significant intellectual and non-intellectual factors related to achievement are summarized. In order to approach this part of the review in a more systematic fashion, the studies included have been classified into the three following categories: (1) ability and achievement in engineering school; (2) interests and achievement in engineering school; and (3) personality and achievement in engineering school. The studies included were limited to those which directly related to the thesis of this investigation.

Ability and Achievement in Engineering School

Studies designed to investigate the relationship between intellectual characteristics and academic achievement in engineering school seem to be fairly prevalent and a selected number are presented. These studies employed aptitude tests and achievement tests, either alone or in combination.

Boe (4) conducted a study to determine the efficiency of a battery of psychological tests and high school grades in predicting

academic performance of engineering students. The four predictors used were the American Council on Education Psychological Examination (ACE), the Cooperative English Test, a locally developed Mathematics Placement Test, and the high school grade-point average. For a sample of 116 third year engineering students he found that the multiple R of all predictors with the criterion (three year grade-point average) was .54. The English and ACE combined resulted in an R of .43 with the criterion while the mathematics test and ACE combined yielded an R of .44.

An investigation was conducted by Eells (14) which resulted in a multiple R of .47 between grade-point average of engineering students at the end of the first semester and a battery of five tests chosen from a larger number to maximize predictions. The variables and their independent correlation with grade-point average were as follows: School and College Ability Test (SCAT)-Verbal, .25; SCAT-Quantitative, .40; Essential High School Content Battery (EHSCB)-Math, .39; EHSCB-Science, .35; EHSCB-Social Studies, .26; Co-operative English Test (CET)-Vocabulary, .28; DAT Language Usage, .24; and DAT Space Relations, .18.

Chansky (9) used the Scholastic Aptitude Test (SAT) and high school class rank to investigate the relationship of ability and high school achievement to academic success in engineering. He found an r of .16 between SAT Verbal and first semester grade-point average, an r of .16 between high school class rank and the grade-point average. The multiple R for SAT Math and high school rank was .49.

Sharp and Pickett (46) investigated the usefulness of the General Aptitude Test Battery (GATB) as a predictor of success in engineering

school. Using a sample of 47 junior and senior engineering students, he found the following correlations between grade-point average and subtests on the GATB: Intelligence, .44; Verbal Aptitude, .39; Numerical Aptitude, .26; Spatial Aptitude, .33; Form Perception, .35; Clerical Perception, -.10; Motor Coordination, .12; Finger Dexterity, .09; and Manual Dexterity, .03.

Jones (32) compared the effectiveness of the Pre-Engineering Ability Test (PEAT) and the American College Testing Program (ACT) in predicting first semester grade-point average in selected engineering courses. The r between PEAT and grade-point average was .61 while the r between ACT Composite and grade-point average was .64.

Ralph F. Berdie and his associates at the University of Minnesota have made a continuing effort to study the validities of tests used for counseling and selecting prospective engineering students. Swanson and Berdie (55) have reported a recent study which has significance for the present investigation. For a sample of 620 freshman engineering students they found the correlations between first quarter grade-point average and selected predictors to be as follows: high school grade-point average, .39; score on the Minnesota Scholastic Aptitude Test, .34; score on the Co-operative English Test, .37; score on the Institute of Technology Mathematics Test, .63; Composite score on the American College Testing Program, .44; Verbal score on the College Entrance Examination Board (CEEB), .41; and the Mathematics score on the CEEB, .42. It is interesting to note that the ACT Composite, a measure of general scholastic aptitude which results from an additive combination of four ACT subtests, showed the second highest correlation with first quarter grade-point average. Selected multiple

correlations were only slightly higher than the independent correlations for the Institute of Technology Math score and the ACT Composite score.

Bowers (5) used two groups of engineering freshmen to investigate the predictive effectiveness of tests used in the counseling program of Oklahoma State University. For Group I, which consisted of 243 first semester engineering freshmen, the following correlations with grade-point average were found: American Council on Education Psychological Examination, .42; Pre-Engineering Ability Test, .58; the Minnesota Paper Form Board Test, .26; and Cooperative Algebra Test, .58. For Group II, which consisted of 492 freshmen engineering students, the correlations were as follows, respectively: .50; .60; .17; and .55. All of the r 's were significant at the .05 level of confidence for Groups I and II.

Stinson (53) studied various differences of the following groups of engineering enrollees: (1) those who successfully completed the program and graduated; (2) those who transferred to some other four-year program on the campus and graduated; and (3) those who dropped out and did not graduate. In part, she was interested in whether the three groups differed significantly in ability as measured by the following: (1) the total score on the American Council on Education Psychological Examination, the scores on the Co-operative Algebra Test, and the scores on a locally developed English Placement Test. Stinson found that the engineering graduates scored significantly higher than the non-engineering graduates on all tests except English Placement and Verbal Comprehension. The engineering graduates scored significantly higher than the dropout group on all ability tests.

She concluded that while verbal ability is of the utmost importance in being successful in any college program, successful engineering students must, in addition to verbal ability, possess certain abstract abilities such as general reasoning and ability to work effectively with mathematical concepts.

Baker (2) found a multiple correlation of .77 between first semester engineering grades and six of the "most efficient" predictors (Purdue Physical Science-Mathematics Operations, Purdue English-Reading, ACE-Arithmetic, Purdue English-Errors, and the Purdue Physical Science-Problem Analysis). In a cross-validation population he reported a correlation of .60 between predicted grades and obtained grades.

A few studies of the relationship between mechanical comprehension and success in engineering school have been reported in the literature. Halliday, Fletcher, and Cohen (24) reported the results of a one-year follow-up study of 105 freshman students in the College of Engineering at Ohio State University who took Form CC of the Bennett Mechanical Comprehension Test. The authors found a correlation of .40 between scores on the Bennett and first year grade-point average. When the efficiency of the Bennett was compared to that of the Ohio State Psychological Test the authors concluded that:

. . . use of the Form CC adds little to the overall correlations obtained with the Ohio State Psychological Test; and (2) when time of administration is an important factor, the thirty to forty minutes required for the Form CC may make this test preferable to the Ohio State Test, which requires two to three hours. (24, p. 324)

Owens (40) reported the following correlations for the Bennett Form CC and selected engineering courses: .49 with theoretical and

applied mechanics; .39 with drawing and projection; and .34 with chemistry.

Interests and Achievement in Engineering School

Vocational interest measurement has often been singled out by psychologists and educators as offering a potential contribution to the prediction of scholastic success. Although interest inventories have been used widely in counseling college students, few experimenters have reported a strong predictive relationship between measured interests and academic performance.

As part of the investigation summarized earlier, Bowers (5) used two groups of engineering freshmen to study the relationship between scores on the ten scales of the Kuder Preference Record and first semester grade-point average. For Group I (N of 343) all of the correlations between the scores on the various scales of the Kuder and grade-point average were very low except the Computational which yielded a correlation of .21, the Outdoor with a correlation of .20, and the Scientific with a correlation of .14. The lowest correlation was between the scores on the Persuasive scale and grade-point average. In a cross validation study of 492 freshman engineering students Bowers obtained very similar coefficients.

Stinson (53) found significant differences to exist among three groups of engineering students on the Scientific and Clerical scales of the Kuder Preference Record. The engineering graduates had significantly higher Scientific interests than either the non-engineering graduates or the dropouts. However, there was no significant difference between the non-engineering graduates and the dropouts on this

scale. The engineering graduates scored significantly lower on the Clerical scale than did the dropouts, but there were no significant differences between the engineering graduates and non-engineering graduates in Clerical interest. Neither were the differences significant between the non-engineering graduates and the dropouts. None of the other scales of the Kuder Preference Record resulted in a significant F-value.

Barnette (3) conducted a follow-up study of veterans who went into engineering after receiving counseling at the Vocational Service Center of the YMCA of New York City. He used the Kuder Preference Record to find if there were significant differences in expressed interest between the successful group (students still in engineering school with no plans to change), and the failure group (students who dropped out of engineering school). He found the groups to differ on four of the scales as follows: (1) Computational was higher for the successful, (2) Scientific was higher for the successful, (3) Persuasiveness was higher for the failure, and (4) Clerical was higher for the successful.

Speer (50) used the Kuder Preference Record to investigate the interest patterns of freshman engineering students as compared to freshman liberal arts students. He found interest patterns of engineering students to differ significantly from those of non-engineering students. The engineering students had high (above the 75th percentile) mechanical, computational, and scientific interests, whereas there seemed to be no such uniformity of interests for the liberal arts students. Speer (49) also found that the engineering students tended to score low in the persuasive and social service interest

areas. Similarly, Darley and Hagenah (10) found that students of equivalent ability enrolled in the College of Liberal Arts and Engineering had widely different interest patterns on the Strong Vocational Interest Blank.

Taylor and Bondy (56) used the Strong Vocational Interest Blank to examine the differences in interest profile patterns of male Trade and Industrial students (non-college level program) and male Collegiate Technical Students at Ferris State College. The Collegiate Technical students had significantly more primary and secondary scores in the Biological Science, Musical, and Certified Public Accountant interest families. The Trade and Industrial students had a significantly greater number of primary and secondary scores in the Production Manager and Technological interest families.

The study mentioned earlier done at Pennsylvania State University by Herman and Zeigler (28) was in part directed at studying the differences in interest patterns of students enrolled in the four-year engineering curriculum and students enrolled in the two-year technical program. When members of each curriculum were categorized according to grade-point average of two or above (high achievers), grade-point average below two (low achievers), and withdrawal from the University, it was found that interest (Strong Vocational Interest Blank) and degree of success seemed to be more related than interests and curriculum. The high achievers in both curriculums generally exhibited stronger interests in engineering and chemistry than did either the low achievers or the withdrawals. The author concluded that:

. . . there is some tendency for achievement in the curriculum and interest in engineering and chemistry to go together, and to a somewhat lesser extent, for achievement

and interest in teaching mathematics and science to go together. (28, p. 83)

There appears to be evidence available indicating that successful engineering students tend to be interested in activities of a mathematical and scientific nature. Also, there is evidence available indicating that the measured interests of engineering students is significantly different from the interests of students in other college majors. The Herman and Zeigler study suggests that it is important to determine whether or not certain psychological traits differentiate between individuals in fields which seem to have much in common such as the engineering and engineering technology programs.

Personality and Achievement in Engineering School

Recently there has developed increased research interest in non-intellectual factors, especially personality variables, as an additional relevant source of variance in the prediction of academic achievement. However, the question of whether a standardized personality scale measures something not satisfactorily measured by the usual predictors of college achievement has not been adequately evaluated. Some studies appear to show definite relationships between measured personality traits and academic achievement, whereas other reports seem to be contradictory.

In the previously discussed study made by Miller (35), it was found that when compared with technician students, engineering students were more theoretically oriented with a significantly higher need to dominate and more motivation for achievement. The technician students had a significantly greater need for nurturance than the engineers. However, Gebhart and Hoyt (19) found that engineering

students scored significantly higher than arts and science students on the Endurance scale and significantly lower on the Dominance scale of the Edwards Personal Preference Schedule. The non-dropouts in Miller's study had significantly higher motivation to achieve and higher economic needs orientation than did the dropouts. The dropout group had significantly higher needs for affiliation and nurturance than the non-dropout.

Grande and Simons (22) conducted an investigation to determine if certain values reflecting personal-social orientations would differentiate between engineering students who earned dean's list status and those who incurred academic probation. They found that the achieving students had a stronger need for achievement, deeper involvement in struggling for successful academic performance, stronger belief in the efficacy of planning as an ingredient of academic success, sharper definitions of self as one who works hard academically, and a greater degree of self-control. Also, in another study, Grande (21) found that achieving freshman engineering students who remained in engineering differed from those who withdrew in that the achieving students had a higher need for achievement, perceived themselves as being hard workers, and were more self-controlled and deliberate.

French, (17) reported a multi-variable study to determine the usefulness of pure-factor tests for the comparative prediction of success in college fields of study. The personality scales were adopted from items found to be relatively pure on personality factors in the literature and from items in the Personality Research Inventory. For a sample of 254 engineering students he found that the personality variables were not highly related to the criterion of major field

grades. For the engineering students there was a small positive relationship between grades and persistence score while this direction was reversed for the gregariousness scale.

As part of a larger study, Brown and Dubois (7) investigated the question of whether personality variables could be used to improve the prediction of academic achievement of engineering students. The subjects used were 190 engineering freshmen and the criterion of performance was cumulative grade-point average for the fall and winter quarter. The personality measure was the Minnesota Multiphasic Personality Inventory. The MMPI was scored on the usual validity and diagnostic scales and, in addition, was scored on the Ego Strength (ES) scale and seven special scales relating to academic achievement. Three of the MMPI scales were significant. There was a negative correlation between grades and scores on the Pd (-.24) and Ma (-.19) scales and a positive relationship (.24) between grades and scores on the special achievement scales. However, Stinson (53) found no statistically significant difference between engineering graduates, non-engineering graduates, and dropouts on the nine clinical scales of the MMPI.

Goodstein and Heilbrun (20) conducted a study which, although not directly concerned with engineering students, yielded outcomes that seem pertinent to this study. They investigated the question of whether a personality measure (Edwards Personal Preference Schedule) can contribute to the prediction of academic success in an unselected group of college students. For a sample of 206 male undergraduate students the authors found an r of .24 between Achievement need score and grade-point average. Although this was the only significant

scale for the total group, several other scales were found to be significant when the students were classified into three subgroups based upon ability levels.

Stagner (51) has asserted that it:

. . . becomes increasingly clear that personality influences achievement in an indirect way, by affecting the degree to which use is made of the individual's potentialities and may explain the low correlations between personality test scores and achievement. At some point along the distribution personality is an advantage in academic work while different amounts of the same personality variable may be disadvantageous, or may be operative in one direction in one case, the opposite in a similar situation. (p. 660)

In discussing the interaction of academic achievement and personality patterns Gebhart and Hoyt (19) suggested that:

. . . three different patterns of overachievement can be hypothesized: (a) overachievement associated with a drive to complete (Achievement); (b) overachievement associated with a drive to organize or plan (Order); and (c) overachievement associated with intellectual curiosity (Intracception). Similarly, two patterns of underachievement may be hypothesized: (a) that associated with a need for variety (Change,) wherein academic studies may appear boring and routine; and (b) that associated with social motives (Affiliation, Nurturance), wherein friendship may be placed above scholarship. (p. 126)

Summary

In summarizing this review of the literature one can only conclude that the intellectual and non-intellectual factors which contribute to both program choice and academic success are many and complex. In addition to factors of scholastic aptitude, mechanical reasoning, mathematical skills, and reading skills, other contributing factors such as vocational interests and personality variables must somehow fit into the causal pattern.

Almost all of the published literature deals with research involving students who are baccalaureate degree candidates. Apparently because of the relatively recent growth of engineering technician programs, very little research is available which concerns college-level engineering technician students in associate degree programs. One can only hypothesize that the factors that contribute to successful achievement in engineering programs also contribute in a large measure to achievement in technical institute programs. This hypothesis, however, might not be supported empirically.

Several studies have indicated that the intellectual characteristics of a student are the major factors which contribute to his academic success. However, it is apparent that these variables do not account for all of the variance in predicting success; other variables such as interests and personality have been credited with contributing to some portion of the variance. There is disagreement as to the contribution of any one variable in part because they tend to manifest themselves somewhat differently with different subjects in varying environments.

Relevant research demonstrating a significant relationship between interest and academic achievement appears to be at a minimum. The studies which have been reported suggest a very low correlation and few significant results. Studies using interest tests have usually been concerned with the Kuder Preference Record or the Strong Vocational Interest Blank. The scales on the Kuder Preference Record which appear to differentiate engineering students from those in other majors are the Scientific and Computational scales, and, to a lesser extent, the Mechanical scale.

Recent research has found various personality variables to be associated with achievement in engineering school. From the review of the literature the following personality characteristics can be recognized as being positively associated with academic achievement: greater need for achievement, greater economic need orientation, sharper definition of self, greater self-control, and higher endurance need. It has also been noted that the better adjusted students tend to achieve higher than students not as well adjusted. Achievement is influenced by personality indirectly by affecting the degree to which effective use is made of the individual's potentialities.

The literature reveals evidence of differences in personality traits among college majors, the greatest differences being evident between those students pursuing programs in the physical sciences and those pursuing training in the helping professions and the humanities. In addition, it would appear interesting both for counseling purposes and for vocational development theory to determine whether or not certain personality variables differentiate between individuals in fields which seem to have much in common such as engineering and engineering technology.

From the review of the literature concerning engineering and engineering technology students certain concepts and postulates emerge which provide this study with tenable guides. These postulates not only suggest areas to be investigated but include suggestions for the selection of appropriate types of instruments needed to carry out an investigation. The postulates are as follows:

- (1) The correlation of a predictor with academic achievement tends to vary among different institutions.

(2) A combination of several measures tends to have a multiple correlation with academic achievement which is higher than the correlation of any single predictor.

(3) A need exists for evaluating both intellectual and non-intellectual factors when studying program choice in college and achievement in that program.

(4) Scholastic aptitude is related to program choice in college and to academic achievement in that program.

(5) Mechanical comprehension is related to program choice in college and academic achievement in that program.

(6) Mathematical skills are related to both program choice in college and achievement in that program.

(7) Reading skills are related to both program choice in college and academic achievement in that program.

(8) Interests, as measured by a standardized interest inventory, are related to both program choice in college and academic achievement in that program.

(9) Personality variables, as measured by a standardized pencil and paper inventory, are related to both program choice and academic achievement in that program.

Chapter III will include a discussion of the instruments selected to implement this study, a description of the subjects in question, and a statement of the hypotheses which evolved from the postulates stated above.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

This chapter contains a description of the subjects employed in the investigation and the instruments selected to measure characteristics presumed to be related to academic success in engineering programs and engineering technology programs. Included are the hypotheses evolving from presumed relationships between tested characteristics and academic achievement.

Subjects

The subjects utilized in this study were selected from three populations of freshman male students who entered different programs administered by the College of Engineering of Oklahoma State University in the fall of 1967. Group I consisted of 60 freshman students randomly selected from the larger population of over 470 freshman on-campus engineering students. Group II consisted of 90 freshman students enrolled in the on-campus technical institute. This number included 88 per cent of the total population of full-time freshman male technical institute students with less than 15 hours of previous college credit. Group III consisted of 87 freshman students enrolled in the metropolitan technical institute. This number included 86 per cent of the total population of full-time male students with less than

15 hours of previous college credit. The number of technical students in each group who actually participated in providing these data were those who had enrolled in the course Personal and Occupational Guidance, which is required by the College of Engineering.

Table I presents the mean and standard deviation in chronological age for each of the three groups.

TABLE I
MEAN AND STANDARD DEVIATION CHRONOLOGICAL
AGE FOR GROUPS I, II, AND III

	GROUPS		
	(I) On-Campus Engineering Subject	(II) On-campus Tech. Inst. Subject	(III) Metropolitan Tech. Inst. Subject
Number	60	90	87
Mean Age	18.2	18.7	22.2
SD Age	.90	2.2	5.5

The results of the Duncan's new multiple range test (52) for testing the significance of the difference between the means of the three groups in chronological age are presented in Table II.

TABLE II
SIGNIFICANCE OF DIFFERENCE IN MEAN CHRONOLOGICAL
AGE OF GROUPS I, II, AND III

Groups	Difference Between Means	LSR Values	P
III, I	4	1.65	.01
III, II	3.5	1.42	.01
II, I	.5	1.17	NS

The metropolitan technical institute students (Group III) had a mean chronological age of 22.5 years which was significantly larger than both the mean age of 18.2 years for the on-campus engineering subjects (Group I) and the mean age of 18.7 years for the on-campus technical institute students (Group II). The difference in mean age between the two on-campus groups was not significant at the .05 level.

A summarization of the subjects in each group by choice of curriculum is provided in Table III.

Instruments

In this investigation four standardized tests were used for the purpose of measuring intellectual factors. The instruments used were the American College Testing Battery, the Cooperative Algebra Test, the Nelson-Denny Reading Test, and the Owens-Bennett Test of Mechanical Comprehension.

The American College Test Battery (ACT). In this study a single score representing scholastic aptitude was desired. The American

TABLE III

PROGRAM CHOICE OF 237 FRESHMAN STUDENTS
EMPLOYED IN THIS INVESTIGATION

Group I			Group II			Group III		
Program	(N)	Percent	Program	(N)	Percent	Program	(N)	Percent
Chemical	(7)	12	Radiation	(12)	13	Computer Progr.	(22)	25
Civil	(3)	5	Metallurgy	(2)	2	Civil	(7)	8
Electrical	(12)	20	Electrical	(6)	7	Electronics	(25)	29
General	(2)	3	Electronics	(17)	19	Instru.& Proc. Control	(6)	7
Industrial	(5)	8	Construction	(4)	4	Draft.& Design	(24)	28
Mechanical	(10)	17	Mechanical	(16)	18	Undecided	(3)	3
Aeronautical	(7)	12	Aeronautical	(18)	20			
Undecided	(14)	23	Petroleum	(5)	6			
			Draft.& Design	(9)	10			
			Undecided	(1)	1			
TOTAL	(60)	100	TOTAL	(90)	100	TOTAL	(87)	100

College Test Battery (ACT) is described by the publishers as a test designed to measure as precisely as possible the ability of a student to perform those intellectual tasks he is likely to face in his college studies. In the test emphasis is placed on generalized skills and abilities such as organization, criticism, judgment, and evaluation rather than on a knowledge of the factual organization and content of classroom courses (1).

The ACT test provides individual scores representing scholastic aptitude in English, Mathematics, Social Studies, and Natural Sciences; in addition, the test also yields a composite score which is the mean of four individual subtests. The publisher defines the composite score as follows:

The composite score is the mean of the four educational development scores. It is viewed as an index of total educational development and has proved to be the best single predictor of freshman success in college. (1, p. 10)

Therefore, for the purposes of this study, the composite score of the ACT was considered to provide an adequate measure of scholastic aptitude. The reported reliabilities of the ACT scores range from .83 to .88 with a median of .85 (1). Brown (6) found ACT scores to be significantly related to achievement in technology courses and Jones (32) obtained an r of .64 between ACT composite score and first semester engineering grade-point average. Also, Swanson and Berdie (55) reported an r of .44 between ACT composite and first semester engineering grades.

The Cooperative Algebra Test, Form A, (CAT). The Cooperative Algebra Test was developed by the Educational Testing Service to measure students' comprehension of the basic concepts, techniques, and

unifying principles of elementary algebra. Ability to apply understanding of mathematical ideas to new situations and to reason with insight are emphasized while factual recall and computations are minimized (12). The Cooperative Algebra Test consists of forty, five-choice items, and the administration time is forty minutes. Since this test is a measure of developed abilities, content validity is of primary importance. Thus the Cooperative Algebra Test was developed by subject-matter specialists who worked with test technicians. Although predictive validity has not been reported for the new Form A used in this study, Super and Crites (54) state that scores on earlier forms of the CAT correlate moderately high (.30 to .50) with college grades. Measures of internal consistency, computed using the Kuder-Richardson Formula 20, are reported for four groups of high school students. The coefficients ranged from .84 to .86 (12). Bowers (5) found an r of .58 between scores on an earlier form of the CAT and grade-point average received in engineering school.

The Nelson-Denny Reading Test (NDRT). This examination was written for use in grades 9 through 16, with norms established for each grade level. The NDRT is a 30-minute test with a 100-item vocabulary section and a 36-item reading comprehension section of the traditional multiple-choice types. It yields four scores - vocabulary, comprehension, total, and reading rate. The comprehension and vocabulary sections are combined in arriving at a total score (the comprehension score is given double weight). It is of reasonable cost and is one of the better reading tests (8). Garrett (18) examined several factors related to academic performance and found the NDRT demonstrated an r of .67 with academic achievement. Crites (8) asserts

that the NDRT appears quite reliable and there is some evidence of its validity for a number of purposes. Reviewers in the Sixth Mental Measurements Yearbook are critical of the NDRT reading rate scale, pointing out two major difficulties: the reading rate sentences are poorly written and overly complex, and the word-count provided at the end of each sentence is not necessarily an accurate count of the words contained in the sentence. Also, since the test respondent is asked to mark his own rate score at the end of one minute, two further shortcomings are suggested by the critics (8). First, there is no adequate method of determining whether the respondent marked the correct level. Secondly, the one-minute reading period is regarded as insufficient time for a reading rate score. In part because of these difficulties, the rate score was not included in this study. For the purposes of this investigation, use of the total reading score appeared most desirable. The authors of the NDRT assert that:

For screening and for prediction of academic success, the total score is most useful. For diagnosing individual problems, strengths, and weaknesses, the subtest scores in vocabulary, comprehension, and rate are most useful. (37, p. 3)

Brown (6) reported correlation coefficients ranging from .30 to .38 between NDRT scores and grade-point average received in engineering technology courses.

The Owens-Bennett Test of Mechanical Comprehension (BMC). For the purposes of this investigation, it was desirable to select an instrument which might measure an intellectual factor related to academic achievement in professional engineers or engineering technology and yet not be directly related to verbal or numerical aptitude. The BMC seemed to meet this criterion in that it was

designed to measure the ability of an individual to understand various kinds of physical and mechanical relationships thought to be of value in engineering and allied areas (41). The BMC was developed after a survey of existing tests of mechanical aptitude led the test authors to conclude that there was a need for a test which would measure a higher order of mechanical aptitude than that assessed by available tests. Form CC, which is used in this study, is reported by the authors to be more difficult and to yield a slightly wider range of scores at high ability levels than preceding forms AA, BB, and WI. This form contains sixty items of the five-alternative multiple-choice type which are more diagrammatic and less pictorial than the items of the previous forms. The Owens-Bennett Form CC was designed specifically for use with engineering students and has no time limit, being designed as a power rather than a speed test. The authors assert that most subjects can complete the test in 25 minutes and that 30-minutes time limit is ample for about any group. No time limits were used in the present study. Reliability coefficients reported for five groups of engineering students range from .75 to .81 (41). Owens (40) correlated scores on Form CC with the engineering grades of groups of students ranging from 107 to 260 in number. The coefficients ranged from .28 to .49, the biserial correlation with passing-failing was .59. Halliday, Fletcher, and Cowen (24) used Form CC with 105 engineering freshman and obtained a correlation of .40 with first-year averages. It was hoped that the BMC would provide additional dimensions relevant to success in the professional engineering and the engineering technology programs.

In this investigation two standardized inventories were used for

the purpose of measuring non-intellective factors. The instruments used were the Kuder Preference Record, Form CH, and the Edwards Personnel Preference Schedule.

Kuder Preference Record, Form CH (KPR). The Kuder Preference Record is a self report instrument developed to measure an individual's major interests through forced-choice items arranged in triads. From the three alternatives the respondent selects that which he likes best and that which he likes least. There are 168 items assessing interest in the ten major interest areas described by the author as follows:

0. Outdoor: Indicates a preference for work that keeps one outside most of the time, usually dealing with animals and growing things.
1. Mechanical: Indicates a preference for work with machines and tools.
2. Computational: Indicates a preference for working with numbers.
3. Scientific: Indicates a preference for discovering new facts and solving problems.
4. Persuasive: Indicates a preference for meeting and dealing with people, and promoting projects or things to sell.
5. Artistic: Indicates a preference for doing creative work with one's hands. It is usually work that has "eye appeal" involving attractive design, color and materials.
6. Literary: Indicates a preference for reading and writing.
7. Musical: Indicates a preference for going to concerts, playing instruments, singing, or reading about music and musicians.
8. Social Service: Indicates a preference for helping people.
9. Clerical: Indicates a preference for office work that requires precision and accuracy. (33, p. 2)

There is also a verification scale intended to identify persons

who may have responded carelessly. Super and Crites (54) summarized the Kuder reliability data as follows:

For Form C the Kuder-Richardson reliability coefficients, which are conservative estimates, range from .84 to .90 (100 girls); from .85 to .93 (100 boys); from .87 to .90 (100 women); and from .85 to .92 (1000 men). (p. 471)

Inclusion of the Kuder in the present study was based, in part, upon the findings of Bowers (5) and of Stinson (53) who found significant differences in the measured interests of successful as compared to non-successful engineering students.

The Edwards Personal Preference Schedule (EPPS) The EPPS was developed, according to its author, primarily as an instrument for research and counseling purposes, to provide quick and convenient measures of a number of relatively independent normal personality variables (13). The measures of the normal personality are based upon fifteen needs identified by Murray (36) and are defined by the author of the EPPS as follows:

1. ach Achievement: To do one's best, to be successful, to accomplish tasks requiring skill and effort, to be a recognized authority, to accomplish something of great significance, to do a difficult job well, to solve difficult problems and puzzles, to be able to do things better than others, to write a great novel or play.
2. def Deference: To get suggestions from others, to find out what others think, to follow instructions and do what is expected, to praise others, to tell others that they have done a good job, to accept the leadership of others, to read about great men, to conform to custom and avoid the unconventional, to let others make decisions.
3. ord Order: To have written work neat and organized, to make plans before starting on a difficult task, to have things organized, to keep things neat and orderly, to make advance plans when taking a trip, to organize details of work, to keep letters and files according to some system, to have meals organized and a definite time for eating, to have things arranged so that they run smoothly without change.

4. exh Exhibition: To say witty and clever things, to tell amusing jokes and stories, to talk about personal adventures and experiences, to have others notice and comment upon one's appearance, to say things just to see what effect it will have on others, to talk about personal achievements, to be the center of attention, to use words that others do not know the meaning of, to ask questions others cannot answer.
5. aut Autonomy: To be able to come and go as desired, to say what one thinks about things, to be independent of others in making decisions, to feel free to do what one wants, to do things that are unconventional, to avoid situations where one is expected to conform, to do things without regard to what others may think, to criticize those in positions of authority, to avoid responsibilities and obligations.
6. aff Affiliation: To be loyal to friends, to participate in friendly groups, to do things for friends, to form new friendships, to make as many friends as possible, to share things with friends, to do things with friends rather than alone, to form strong attachments, to write letters to friends.
7. int Intraception: To analyze one's motives and feelings, to observe others, to understand how others feel about problems, to put one's self in another's place, to judge people by why they do things rather than by what they do, to analyze the behavior of others, to analyze the motives of others, to predict how others will act.
8. suc Succorance: To have others provide help when in trouble, to seek encouragement from others, to have others be kindly, to have others be sympathetic and understanding about personal problems, to receive a great deal of affection from others, to have others do favors cheerfully, to be helped by others when depressed, to have others feel sorry when one is sick, to have a fuss made over one when one is hurt.
9. dom Dominance: To argue for one's point of view, to be a leader in groups to which one belongs, to be regarded by others as a leader, to be elected or appointed chairman of committees, to make group decisions, to settle arguments and disputes between others, to persuade and influence others to do what one wants, to supervise and direct the actions of others, to tell others how to do their jobs.
10. aba Abasement: To feel guilty when one does something wrong, to accept blame when things do not go right, to feel that personal pain and misery suffered

does more good than harm, to feel the need for punishment for wrong doing, to feel better when giving in and avoiding a fight than when having one's own way, to feel the need for confession of errors, to feel timid in the presence of superiors, to feel inferior to others in most respects.

11. nur Nurturance: To help friends when they are in trouble, to assist others less fortunate, to treat others with kindness and sympathy, to forgive others, to do small favors for others, to be generous with others, to sympathize with others who are hurt or sick, to show a great deal of affection toward others, to have others confide in one about personal problems.

12. chg Change: To do new and different things, to travel, to meet new people, to experience novelty and change in daily routine, to experiment and try new things, to eat in new and different places, to try new and different jobs, to move about the country and live in different places, to participate in new fads and fashions.

13. end Endurance: To keep at a job until it is finished, to complete any job undertaken, to work hard at a task, to keep at a puzzle or problem until it is solved, to work at a single job before taking on others, to stay up late working in order to get a job done, to put in long hours of work without distraction, to stick to a problem even though it may seem as if no progress is being made, to avoid being interrupted while at work.

14. het Heterosexuality: To go out with members of the opposite sex, to engage in social activities with the opposite sex, to be in love with someone of the opposite sex, to kiss those of the opposite sex, to be regarded as physically attractive by those of the opposite sex, to participate in discussions about sex, to read books and plays involving sex, to listen to or to tell jokes involving sex, to become sexually excited.

15. agg Aggression: To attack contrary points of view, to tell others what one thinks about them, to criticize others publicly, to make fun of others, to tell others off when disagreeing with them, to get revenge for insults, to become angry, to blame others when things go wrong, to read newspaper accounts of violence. (13, p. 11)

The EPPS is composed of 225 pairs of forced-choice statements and the respondent must choose the statement from each pair with which he most nearly agrees. A unique feature of the EPPS is the

determined effort made by the author to control the influence of the social desirability factor in the responses of the examinees.

Two types of reliability are reported for the EPPS. Split-half reliabilities for the fifteen personality variables, based upon the scores of 1,509 subjects and corrected by the Spearman-Brown formula, ranged from .60 (Deference) to .87 (Heterosexuality), with the majority falling in the mid-seventies. For a group of 89 students who were re-examined after a one-week interval, the reliabilities ranged from .74 (Achievement and Exhibition) to .88 (Abasement), with most of the coefficients clustering in the eighties (54). The EPPS was selected for use in the present study for several reasons. First, the EPPS would appear to be especially useful in that many of the personality traits or needs measured by this instrument are logically related to academic success, e.g., Achievement and Endurance. Also, the inclusion of the EPPS allowed an extension of the findings of Gebhart and Hoyt (19) in which differences in personal needs between engineering students and arts and science students were compared. Use of the EPPS also permitted extension of Miller's (35) finding that engineers and technicians differed in personal attributes as measured by the EPPS.

All of the subjects completed the ACT, Nelson-Denny Reading Test, and the Cooperative Algebra Test during the pre-enrollment orientation clinics which were conducted at Oklahoma State University. All of the subjects in Group I completed the KPR and the EPPS at the Bureau of Tests and Measurements of Oklahoma State University. The subjects in Groups II and III completed the KPR and EPPS during their respective orientation classes (TEC 131, Personal and Occupational

Guidance).

Statement of Hypotheses

The statistical hypotheses tested are based upon the postulates stated in Chapter II. Stated in the form of null hypotheses, they are as follows:

Hypothesis I: No statistically significant differences on the following measured characteristics exist among those students tested in the first semester of the freshman year who are enrolled in (1) the on-campus engineering school, (2) the on-campus technical institute, and (3) the metropolitan technical institute:

- (a) Scholastic aptitude as measured by the composite score of the ACT battery.
- (b) Mechanical aptitude as measured by the Owens-Bennett Test of Mechanical Comprehension, Form CC
- (c) Algebra skills as measured by the Cooperative Algebra Test, Form A.
- (d) Reading skills as measured by the Nelson-Denny reading Test, Form A.
- (e) Interests as measured by the ten scales of the Kuder Preference Record, Form CH.
- (f) Personality variables as measured by the fifteen scales of the Edwards Personal Preference Schedule.

Hypothesis II. No statistically significant differences exist between satisfactorily achieving and low achieving engineering and technical institute freshmen students on the following characteristics:

- (a) Scholastic aptitude as measured by the composite score of the ACT battery.
- (b) Mechanical aptitude as measured by the Owens-Bennett Test of Mechanical Comprehension, Form CC.
- (c) Algebra skills as measured by the Cooperative Algebra Test, Form A.
- (d) Reading skills as measured by the Nelson-Denny Reading Test, Form A.

- (e) Interests as measured by the ten scales of the Kuder Preference Record, Form CH.
- (f) Personality variables as measured by the fifteen scales of the Edwards Personal Preference Schedule.

Hypothesis III. For each of the three groups, no statistically significant association exists between first semester grade-point average and the following characteristics:

- (a) Scholastic aptitude as measured by the composite score of the ACT battery.
- (b) Mechanical aptitude as measured by the Owens-Bennett Test of Mechanical Comprehension, Form CC.
- (c) Algebra skills as measured by the Cooperative Algebra Test, Form A.
- (d) Reading skills as measured by the Nelson-Denny Reading Test, Form A.
- (e) Interests as measured by the ten scales of the Kuder Preference Record, Form CH.
- (f) Personality variables as measured by the fifteen scales of the Edwards Personal Preference Schedule.

Statistical Treatment

For the purposes of testing Hypotheses I and II, listed on pages 43 and 44 of this report, the analysis of variance was used as outlined by Wert, Neidt, and Ahmann (59, pp. 191-199).

With this statistical procedure it was possible to test differences among groups, between levels, and to determine the nature of the interaction effects. When significant F's were found, Duncan's new multiple-range test for groups with unequal replication was used to make comparisons among means as suggested by Steel and Torrie (52, 107-114).

A coefficient of correlation was used to determine relationships between first semester grade-point averages and each of the measured

characteristics. Also, an application of multiple regression analysis, stepwise regression, was performed in order that the weights for the variables most highly correlated with the criterion could be determined for predicting the criterion (11).

In order to test Hypothesis II, the subjects were dichotomized into two levels of academic achievement. Level 1 included those students with an overall first semester grade-point average of 1.99 or less. These subjects are referred to as the low-achieving students. Level 2 included those students receiving an overall grade-point average of 2.00 or above. These subjects are referred to as the satisfactorily achieving students.

For all subjects, the criterion of academic performance used in testing the hypotheses was the overall grade-point average received at the end of the first fall semester in school.

The results of these statistical treatments are presented in detail in Chapter IV.

CHAPTER IV

RESULTS OF THE INVESTIGATION

Introduction

The results of this investigation are reported under three major divisions as follows: (1) differences among on-campus engineering freshmen, on-campus technical institute freshmen, and metropolitan technical institute freshmen; (2) differences between satisfactorily achieving and low achieving students; and (3) relationships between measured characteristics and academic achievement.

Analysis of Differences Among the Three Groups

Aptitude and Achievement Measures

An analysis of variance, as described by Wert, Neidt, and Ahmann (59) was used to test the differences among the three groups on the ACT, CAT, NDRT, and the BMC. It was found that the data for each test, when treated, resulted in a significant F value. For the purposes of this study, an associated probability of .05 or less was required for rejection of the null hypothesis; however, for further clarification of results, when a computed value has an associated probability of .01 or less, it will be noted. Thus, the hypothesis that there are no significant differences among the three groups in intellectual characteristics was rejected at the .01 level of confidence for each

test. The mean scores on these instruments for each group along with the computed F values are shown in Table IV.

TABLE IV
MEANS AND F'S FOR GROUPS I, II, AND III
ON APTITUDE AND ACHIEVEMENT TEST DATA

Test	Group I N=60 Mean	Group II N=90 Mean	Group III N=87 Mean	F
ACT Composite	24.45	18.78	16.51	71.90**
Coop. Algebra	30.61	23.44	21.27	18.22**
Bennett Mech. Comp.	38.31	32.78	29.10	28.87**
Nelson-Denny Reading	89.88	66.55	63.09	35.80**

** Significant at the 1% level of confidence

Since a significant F value was found for each test, the Duncan's new multiple range test (52) was used to examine the differences between the three groups.

Table V shows the results obtained when the means of the three groups on the ACT Composite were compared. The engineering students have a mean ACT Composite standard score of 24.45, which is significantly higher than both the mean of 18.78 obtained by the students enrolled in the on-campus technical institute and the mean of 16.51 obtained by the metropolitan technical institute students. The mean Composite ACT score of the on-campus technician group is also signifi-

cantly higher than that received by the metropolitan institute students.

TABLE V
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF
GROUPS I, II, AND III ON THE ACT COMPOSITE

Means	Difference	LSR Values	P
Group I, Group III	7.94	1.80	.01
Group I, Group II	5.67	1.71	.01
Group II, Group III	2.27	1.54	.01

Table VI shows the results obtained when the means of the three groups on the CAT were compared. Again, it was found that the students in professional engineering (raw score mean = 30.61) differ significantly from the on-campus technician students (raw score mean = 23.44) and the metropolitan technician students (raw score mean = 21.27). However, the difference between the technician groups is not significant at the .05 level.

Table VII shows the results obtained when the means of the three groups on the BMC were compared. The engineering freshmen have a mean BMC raw score of 38.31, which is significantly higher than the mean of 32.78 for the on-campus technician students. The

metropolitan institute group has a mean of 29.10, which is significantly lower than the means for both of the other two groups.

TABLE VI
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF
GROUPS I, II, AND III ON THE
COOPERATIVE ALGEBRA TEST

Means	Difference	LSR Values	P
Group I, Group III	9.34	4.25	.01
Group I, Group II	7.17	4.03	.01
Group II, Group III	2.17	2.78	NS

TABLE VII
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF
GROUPS I, II, AND III ON THE BENNETT
MECHANICAL COMPREHENSION TEST

Means	Difference	LSR Values	P
Group I, Group III	9.21	3.43	.01
Group I, Group II	3.53	3.26	.01
Group II, Group III	3.68	2.95	.01

Table VIII shows the results obtained when Duncan's test was used to compare the means of the three groups on the NDRT. The picture presented in this table is very similar to that presented for the CAT. Again it was found that students in professional engineering (raw score mean = 89.88) differ significantly from the on-campus technician students (mean = 66.55) and the metropolitan technician students (mean = 63.09). As in the case of the algebra test, the differences between the two technician groups on the NDRT are not significant at the .05 level.

TABLE VIII
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
NELSON-DENNY READING TEST

Means	Difference	LSR Values	P
Group I, Group III	26.79	9.03	.01
Group I, Group II	23.33	8.57	.01
Group II, Group III	3.45	5.91	NS

From the analyses of the ability and achievement test data it is evident that the engineering students are superior to both groups of engineering technology students in scholastic aptitude, algebra skills, reading skills, and mechanical comprehension.

These results support those of Miller (35) who found engineering students to be superior to technician students in scholastic aptitude as measured by the ACT. Herman and Zeigler (28) found four-year engineering students to be significantly higher than technician students on all subtests of the Pennsylvania State University Academic Aptitude Examination.

A comparison of the scores of the students enrolled in the two technical institutes suggests that they are not homogeneous in intellectual characteristics. The results indicate that the on-campus group is significantly higher in scholastic aptitude and in capacity to understand physical and mechanical relationships. The mean scores of the on-campus technician students were somewhat higher on the algebra test and the reading test; however, the differences were not significant at the .05 level. The on-campus technical students in this study fall between the engineering students and the metropolitan technical institute students on the aptitude and achievement measures.

Table IX presents a summary of the results of the analyses of differences between means on the tests of intellectual characteristics.

Personality and Interest Measures

An analysis of variance was made for each scale of the Edwards Personal Preference Schedule in order to test the hypothesis of no significant differences among the three groups with respect to measured personality variables. The hypothesis was rejected for two of the fifteen scales (Achievement and Order); the differences among the three groups on each of the other thirteen scales was found to be no larger than that which could be attributed to chance fluctuations in random sampling. The mean scores on the EPPS scales for

each group, along with associated F values are shown in Table X.

TABLE IX
SUMMARY TABLE OF ANALYSES OF DIFFERENCES BETWEEN
MEANS OF GROUPS I, II, AND III ON APTITUDE
AND ACHIEVEMENT TESTS

Test	Group I N=60 Mean	Group II N=90 Mean	Group III N=87 Mean
ACT Composite	24.45	18.78	16.51**
Coop. Algebra	30.61	<u>23.44</u>	<u>21.27*</u>
Bennett Mech. Comprehension	38.31	32.78	28.10**
Nelson-Denny Reading	89.88	<u>66.55</u>	<u>63.09*</u>

* Any two means underscored by the same line are not significantly different at the .05 level.

** Any two means not underscored by the same line are significantly different at the .05 level.

TABLE X
MEAN EPPS RAW SCORES FOR FRESHMEN STUDENTS
INCLUDED IN THIS STUDY

EPPS Scale	Group I N=60 Mean	Group II N=90 Mean	Group III N=87 Mean	F
Achievement	15.98	14.85	14.41	3.62*
Deference	10.98	11.41	12.81	2.25
Order	9.90	11.77	12.12	5.85**
Exhibition	14.98	14.54	14.70	.24
Autonomy	14.51	13.80	12.95	2.23
Affiliation	13.78	13.74	13.45	.17
Intraception	14.68	14.07	14.29	.30
Succorance	10.35	11.24	10.71	.81
Dominance	15.33	13.56	14.19	1.98
Abasement	15.60	14.85	14.54	.88
Nurturance	12.91	13.50	13.75	.63
Change	15.01	16.36	15.94	1.87
Endurance	13.86	14.60	15.62	1.93
Heterosexuality	17.70	16.83	17.75	.55
Aggression	13.43	13.62	13.52	.03

* Significant at the 5% level of confidence

**Significant at the 1% level of confidence

Since a significant F value was found for the Achievement and Order scales, the Duncan's new multiple range test was used to examine

the differences between the three groups.

Table XI shows the results obtained when the means of the three groups on the EPPS Achievement scale were compared. The engineering students have a mean EPPS Achievement score of 15.98 which is significantly higher than the mean of 14.41 obtained by the metropolitan technical institute students. The mean of 14.85 for the on-campus technician students is not significantly different from the means of either of the other two groups. According to these results, the engineering students manifest a greater need to be successful and to accomplish tasks requiring skill and effort than do the older students enrolled in the metropolitan technical institute.

TABLE XI
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
EPPS ACHIEVEMENT SCALE

Means	Difference	LSR Values	P
Group I, Group III	1.57	1.22	.05
Group I, Group II	1.13	1.15	NS
Group II, Group III	.44	1.04	NS

Table XII shows the results obtained when the means of the three groups on the EPPS Order scale were compared. The engineering students have a mean score of 9.90 on the EPPS Order scale which is significant-

ly lower than the mean of 11.77 obtained for the on-campus technician students and the mean of 12.12 for the metropolitan technical institute students. There is no significant difference between the two technician groups on this scale. The results of this analysis indicate that the technician students, to a greater extent than the engineering subjects, manifest a greater need to have things neatly organized and well planned.

TABLE XII
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF
GROUPS I, II, AND III ON THE
EPPS ORDER SCALE

Means	Difference	LSR Values	P
Group III, Group I	2.22	1.94	.01
Group III, Group II	.35	1.67	NS
Group II, Group I	1.87	1.85	.01

In summary, the analysis of EPPS results seem to indicate the engineering students, as compared to the technician students, tended to express a greater need to succeed, to accomplish difficult tasks, and to do difficult jobs well. The results also suggest that the engineering students, as compared to the technician students, tended to express a lesser need to have things well organized and to organize details of work. Although these outcomes are suggested by the

differences on the Achievement and Order scales, when the analysis of results for all scales is considered, it appears that the three groups are quite homogeneous in personality variables as measured by the EPPS. These results suggest that the EPPS has limited value for differentiating between individuals entering fields which seem to have much in common such as professional engineering and engineering technology.

An analysis of variance was made for each scale of the KPR in order to test the hypothesis of no significant differences among the three groups with respect to measured interests. The hypothesis was rejected for six of the ten scales: Outdoor, Mechanical, Computational, Literary, Musical, and Social Service. The differences between the groups on the other scales (Clerical, Artistic, Persuasive, and Scientific) were found to be no larger than that which could be attributed to chance fluctuations in random sampling. The mean scores on the ten Interest Scales for each group, along with the associated F values, are shown in Table XIII.

The Duncan's new multiple range test was used to examine the differences between the three groups for each of the six scales yielding a significant F Value.

Table XIV contains the results obtained by comparing the means on the Outdoor scale for the three groups. The engineering students have a mean score of 38.43 on the KPR Outdoor scale which is significantly lower than the mean of 45.49 obtained by the metropolitan technical institute students, and the mean of 46.52 for the on-campus technician students. The difference between means for the two technical institute groups is not significant at the .05 level. Thus, the freshman subjects entering programs in technology express a greater

interest in work that is outside and that usually deals with animals and growing things than do the engineering students.

TABLE XIII
MEAN KPR RAW SCORES FOR FRESHMEN STUDENTS
INCLUDED IN THIS STUDY

KPR Scale	Group I N=60 Mean	Group II N=90 Mean	Group III N=87 Mean	F
Outdoor	38.43	46.52	45.49	7.04**
Mechanical	45.26	47.97	44.03	3.201*
Computational	32.76	29.56	33.17	6.01** ✓
Scientific	48.03	46.70	45.77	0.983
Persuasive	37.45	36.21	35.40	.55
Artistic	28.05	28.43	28.12	.02
Literary	17.31	14.87	18.42	4.82**
Musical	12.75	10.76	9.02	6.27**
Social Service	31.40	34.72	37.44	6.25** ✓
Clerical	48.56	46.83	48.21	.62

* Significant at the 5% level of confidence

** Significant at the 1% level of confidence

Table XV shows the results obtained when the means of the three groups on the Computational scale were compared. The on-campus technical institute students have a mean score of 29.56 on the KPR.

Computational scale which is significantly lower than the mean of 33.17 for the metropolitan institute students and the mean of 32.76 for the on-campus engineering students. The difference between the metropolitan institute students and the engineering students is not significant at the .05 level. These results indicate that both the engineering freshmen and the older students enrolled in the metropolitan technical institute express a greater interest in working with numbers than do the on-campus technician students.

TABLE XIV
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF
GROUPS I, II, AND III ON THE
KPR OUTDOOR SCALE

Means	Difference	LSR-Values	P
Group II, Group I	8.09	6.12	.01
Group II, Group III	1.03	4.04	NS
Group III, Group I	7.06	5.91	.01

Table XVI shows the results obtained when the means of the three groups on the KPR Mechanical scale were compared. The on-campus technical institute group obtained a mean score of 47.97 on the KPR Mechanical scale which is significantly larger than the mean of 44.03 for the metropolitan technical institute group but not significantly different from the mean of 45.26 for the on-campus engineering group.

TABLE XV

SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
KPR COMPUTATIONAL SCALE

Means	Difference	LSR Values	P
Group III, Group II	3.61	3.05	.01
Group III, Group I	.41	2.48	NS
Group I, Group III	3.20	2.46	.05

TABLE XVI

SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUP I, II, AND III ON THE
KPR MECHANICAL SCALE

Means	Difference	LSR Values	P
Group II, Group III	3.94	3.37	.05
Group II, Group I	2.71	3.53	NS
Group I, Group III	1.23	3.56	NS

These results suggest that the on-campus technicians express a greater interest in working with machines and tools than do the older students enrolled in the metropolitan technical institute or the more scholastically able students enrolled in engineering.

Table XVII shows the results obtained by comparing the means of the three groups on the KPR Musical scale. The on-campus engineering students have a mean score of 12.75 on the KPR Musical scale which is significantly higher than the mean of 9.02 for the metropolitan technical institute students, but not significantly different from the mean of 10.76 for the on-campus technician students. The difference between the two technician groups is not significant at the .05 level. Thus, the engineering students express a greater interest in listening to music and playing instruments or reading about music and musicians than do the older students enrolled in the metropolitan technical institute.

TABLE XVII
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
KPR MUSICAL SCALE

Means	Difference	LSR Values	P
Group I, Group III	3.73	2.84	.01
Group I, Group II	1.99	2.06	NS
Group II, Group III	1.74	1.88	NS

Table XVIII shows the results obtained by comparing the means of the three groups on the KPR Literary scale. The metropolitan technical institute students have a mean score of 14.87 on the KPR Literary scale which is significantly lower than the mean of 18.42 for the on-

campus technician students, but not significantly different from the mean score of 17.31 for the engineering students. Thus, the older students entering the metropolitan institute express a lesser interest in academic activities such as writing and reading books than do the students enrolled in the on-campus technical institute.

TABLE XVIII
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
KPR LITERARY SCALE

Means	Difference	LRS Values	P
Group III, Group II	3.55	3.16	.01
Group III, Group I	1.11	2.57	NS
Group I, Group II	2.44	2.55	NS

Table XIX shows the results obtained by comparing the means of the three groups on the KPR Social Service scale. The on-campus engineering students have a mean score of 31.40 on the KPR Social Service scale which is significantly lower than the mean of 37.44 obtained for the metropolitan technical institute students and the mean of 34.72 for the on-campus technicians. The difference between technician groups is not significant at the .05 level. Both of the technical institute groups thus express a greater preference for working with people and helping others than do engineering students.

TABLE XIX
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS
OF GROUPS I, II, AND III ON THE
KPR SOCIAL SERVICE SCALE

Means	Difference	LSR Values	P
Group III, Group I	6.04	4.60	.01
Group III, Group II	2.72	3.01	NS
Group II, Group I	3.32	3.31	.05

It appears that the three groups are not homogeneous in vocational interests as measured by the KPR. However, unlike the findings for the ability measures and the personality measures, the significant differences among the three groups on the interest scales do not present a pattern that is consistent in direction.

The engineering students express a lesser preference for outdoor and social service activities than do either of the two technician groups. The engineering students also express greater computational interests than do the on-campus technician students and a greater preference for musical activities than do the older students enrolled in the metropolitan technical institute.

There are also significant differences between the two technician groups. The on-campus technician students have higher mean scores for mechanical interests and literary interests while the metropolitan institute students demonstrate greater computational interests.

Although the analysis of results indicate several statistically significant differences between the three groups, an inspection of the mean KPR interest scores contained in Table XIII suggests that these differences are of limited practical usefulness in differentiating between students entering the three institutions.

Summary of Differences Among the Three
Groups on Ability, Personality, and
Interest Data

The three groups can be compared with respect to intellectual and non-intellectual characteristics by examining Tables IX, X, and XIII.

From an inspection of Table IX, it is evident that the engineering students are superior to both groups of technician students in scholastic aptitude, algebra skills, reading skills, and mechanical comprehension. Table IX also indicates that the on-campus technician students are superior to the metropolitan technician students in scholastic aptitude and in comprehension of mechanical relationships. Although the differences are not statistically significant, the on-campus technical institute students also have slightly higher mean scores in algebra skills and in reading skills.

The results of the analysis of the EPPS data suggest that the engineering students manifest greater achievement needs while the engineering technology students demonstrate greater order needs. However, an inspection of the mean EPPS scores provided in Table X indicates that the three groups are quite homogeneous in personality variables as measured by the EPPS.

There are several significant differences between the three

groups in vocational interests as measured by the KPR. Both groups of technician students express greater social service and outdoor interests than do the engineering students. The engineering students demonstrate greater computational interests than do the on-campus technician students and greater musical interests than do the metropolitan technician students.

When the differences between technician groups were examined, it was found that the on-campus technician students express greater mechanical and literary interests while the metropolitan technician students demonstrate greater computational interests.

Despite the statistically significant differences found between the three groups in vocational interests, an inspection of Table VIII suggests that the magnitude and direction of these differences are such that they appear to be of limited practical usefulness.

One might conclude, on the basis of the analysis of the twenty-nine variables included in this study, that it is primarily in the realm of mental abilities that one can most consistently and meaningfully differentiate between the three groups.

Differences Between Satisfactorily Achieving and Low Achieving Students

Attitude and Achievement Measures

An analysis of variance, as described by Wert, Neidt, and Ahmann (59), was used to test the differences between satisfactorily achieving and low achieving students on the ACT, CAT, NDRT, AND BMC. This analysis was for data having a two-way classification with proportionate subclass numbers. F values were computed for interaction, effect

due to group, and effect due to achievement level, for each variable being analyzed. No significant interaction was found to exist on any of the ability and achievement measures. The mean scores on these instruments along with the associated F values are shown in Table XX.

TABLE XX
MEANS AND F'S FOR SATISFACTORILY ACHIEVING
AND LOW ACHIEVING STUDENTS ON THE
ACT, CAT, NDRT, AND BMC

Test	Satisfactorily Achieving Mean (N=158)	Low Achieving Mean (N=79)	F
ACT Composite	20.91	16.34	69.15**
Coop. Algebra	27.48	18.43	48.37**
Bennett Mech. Comp.	34.46	29.56	22.29**
Nelson-Denny Reading	75.68	62.20	23.79**

** Significant at the 1% confidence level

An inspection of Table XX indicates that the null hypothesis of no significant differences between mean values of the two groups was rejected at the .01 level for each test. These results appear to imply that satisfactory achievement in the first semester of any of the three programs is associated with a relative greater capacity for understanding complex physical and mechanical relationships and a stronger preparation for college level studies as reflected by measures of scholastic aptitude, understanding of basic algebra, and

reading vocabulary and comprehension.

Interest and Personality Measures

The analysis of variance was also used to test the differences between the satisfactorily achieving and low achieving students on the fifteen scales of the EPPS and the ten scales of the KPR. A significant F ratio for levels and a non-significant F value for interaction was found for the Dominance and Nurturance scales of the EPPS and the Computational and Social Service scales of the KPR. The mean scores on these scales along with associated F values are shown in Table XXI.

TABLE XXI

MEANS AND F'S FOR SATISFACTORILY ACHIEVING AND LOW
ACHIEVING STUDENTS ON THE EPPS DOMINANCE AND
NURTURANCE SCALES AND KPR COMPUTATIONAL
AND SOCIAL SERVICE SCALES

Scale	Satisfactorily Achieving N=158 Mean	Low Achieving N=79 Mean	F
EPPS Dominance	14.62	13.49	4.94*
EPPS Nurturance	12.87	14.59	7.46**
KPR Computational	32.46	30.16	5.27*
KPR Social Service	33.93	36.77	3.95*

* Significant at the 5% confidence level

** Significant at the 1% confidence level

An inspection of Table XXI indicates that the null hypothesis of no significant differences between mean values of the satisfactorily achieving and low achieving students was rejected at the .01 level for the EPPS Nurturance scale. The hypothesis was rejected at the .05 level for the EPPS Dominance scale, the KPR Computational scale, and the KPR Social Service scale. The satisfactorily achieving students obtained a significantly higher mean score on the EPPS Dominance scale and on the KPR Computational scale. The low achieving students obtained a higher mean score on the EPPS Nurturance scale and the KPR Social Service scale.

These results suggest that satisfactory achievement in the engineering and technical institute programs is associated with a relatively greater need to supervise and direct the actions of others and a relatively greater interest in working with numbers. The results also suggest that failure to make satisfactory progress is related to relatively higher nurturance needs and greater interest in working with people and helping others.

A significant F for interaction was found for the Achievement scale or the EPPS and the Mechanical, Scientific, and Persuasive scales of the KPR. The sums of squares and F ratios for these scales are shown in Table XXII.

Since significant interaction results represent a lack of uniformity of scores found among the achievement levels of the various groups, those scales yielding a significant F value for interaction are discussed separately below.

TABLE XXII
 MEAN SUMS OF SQUARES AND F RATIOS FOR EPPS
 SCALES AND KPR SCALES YIELDING
 SIGNIFICANT INTERACTION

Instrument	Source	DF	MS	F	P
EPPS Achievement Scale	Groups	2	44.84	3.62	.05
	Levels	1	54.00	4.36	.05
	Inter- action	2	51.36	4.15	.05
	Within	231	12.36		
KPR Mechanical Scale	Groups	2	376.80	3.20	.05
	Levels	1	.25	.00	NS
	Inter- action	2	584.02	4.96	.01
	Within	231	117.71		
KPR Scientific Scale	Groups	2	115.34	.98	NS
	Levels	1	130.80	1.11	NS
	Inter- action	2	597.19	5.08	.01
	Within	231	117.37		
KPR Persuasive Scale	Groups	2	77.26	.54	NS
	Levels	1	26.46	.18	NS
	Inter- action	2	437.43	3.10	.05
	Within	231	140.93		

The significant F value for achievement levels suggests that those engineering and technical institute students receiving a grade-point average of 2.00 or above demonstrate a greater need to achieve as measured by the EPPS than those students receiving a grade-point average of 1.99 or below. However, the findings relative to achievement level effects must be considered in light of the significant F for interaction which implies that EPPS Achievement scores among levels of the various groups were not uniform. In other words, the levels of the various groups differed in responses on the EPPS Achievement scale.

Inspection of the six subgroup means in Table XXIII and in Figure 1 identifies more specifically the lack of uniformity which caused the significant interaction. For the on-campus engineering students (Group I) and the metropolitan technician students (Group III) the results suggest that the scores on the EPPS Achievement scale tended to increase as the grade-point averages increased. For the on-campus technical institute group, the results suggest that the EPPS scores tended to decrease as the grade-point average increased. In Figure 1, this reversal is shown graphically by the line for Group II, which crosses both the line for Group I and the line for Group III. Note that the mean of Group I is considerably higher than the mean for Group III. This is consistent with the significant F ratio found for group effects.

The results of the analysis of variance for the KPR Mechanical scale are shown in Table XXII. Although the F value for achievement level was not significant, it cannot be concluded that mechanical interests are unrelated to grade-point average due to the lack of

TABLE XXIII

MEAN EPPS ACHIEVEMENT SCORES FOR THREE
GROUPS AND TWO LEVELS OF FRESHMEN
STUDENTS INVOLVED IN THIS
INVESTIGATION

Level	Group I N=60	Group II N=90	Group III N=87	Total
Satisfactory Achievers	16.85	14.61	14.98	15.31
Low Achievers	14.25	15.33	13.27	14.30
Total	15.98	14.85	14.41	14.97

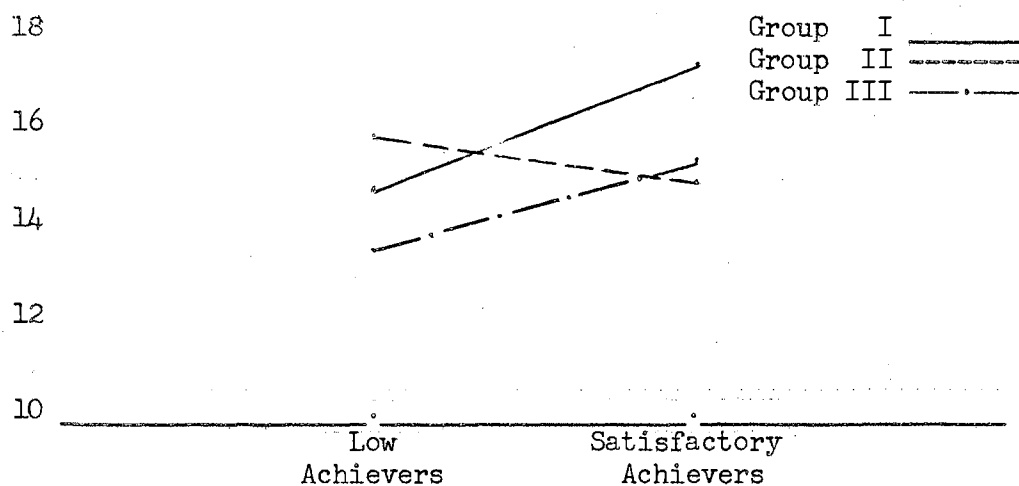


Figure 1. Illustration of Significant Interaction on
the EPPS Achievement Scale

uniformity of scores on the Mechanical scale found among the achievement levels of the various groups.

Inspection of the subgroup means in Table XXIV and Figure 2 reveal the lack of uniformity in Mechanical interest scores found among levels of the various groups which resulted in the significant interaction. For the on-campus engineering students (Group I), and the on-campus technician students (Group II), the results suggest that Mechanical interests tended to increase as the grade-point average increased. For the metropolitan technical institute students the results suggest that the Mechanical interest scores tended to increase as the grade-point average decreased. The significant interaction results produced by this reversal in direction are illustrated quite clearly in Figure 2 by the nearly perpendicular intersection of the lines for Groups I and II and by the line for Group III. Thus, the relationship between grade-point average and score on the Mechanical scale varies from group to group. Note that the mean of Group II is considerably higher than the mean of Group III. This is consistent with the significant F ratio found for group effects.

The results of the analysis of variance for the KPR Scientific scale are shown in Table XXII. The F value for achievement level was not significant at the .05 level. However, this finding relative to level effects must be considered in relationship to the significant interaction results indicating that there was little uniformity of KPR Scientific scores found among the achievement levels of the various groups.

TABLE XXIV
 MEAN KPR MECHANICAL SCORES FOR THREE
 GROUPS AND TWO LEVELS OF
 FRESHMAN STUDENTS

Level	Group I N=60	Group II N=90	Group III N=87	Total
Satisfactory Achievers	46.62	49.20	42.00	45.90
Low Achievers	42.55	45.83	48.10	45.72
Total	45.26	47.97	44.03	45.84

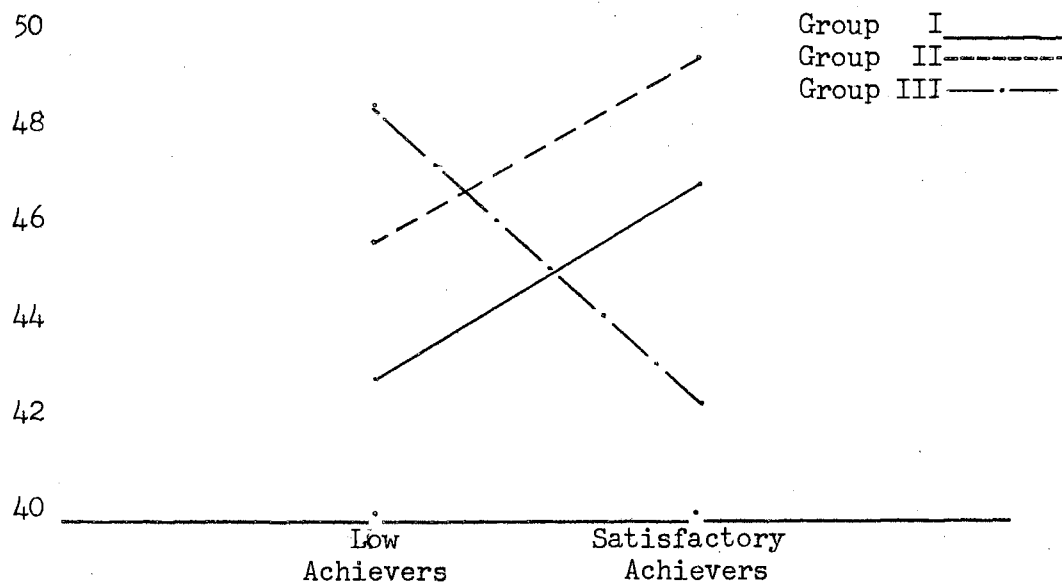


Figure 2. Illustration of Significant Interaction on the KPR Mechanical Scale

Inspection of the subgroup means in Table XXV and in Figure 3 demonstrate the lack of uniformity in Scientific scores which resulted in the significant interaction effects. For both the on-campus engineering students (Group I), and the on-campus technical institute students (Group II), the results suggest that Scientific interests tend to increase as the grade-point average increased. However, as Figure 3 illustrates, the rate of increase is greater for Group I than for Group II which contributes to the interaction effects. For the metropolitan technical institute students (Group III), a reversal in direction is evident and the Scientific interest scores tended to increase as the grade-point average decreased. This very evident failure of the levels of the various groups to maintain consistent Scientific scores is clearly exemplified in Figure 3.

The results of the analysis of variance for the KPR Persuasive Scale are shown in Table XXII. The F value for levels was not significant at the .05 level. Again, as in the case of the scientific scale, these findings relative to no significant achievement level effects must be viewed in light of the significant interaction between groups and levels indicating a lack of uniformity throughout the data.

Inspection of the subgroup means in Table XXVI and Figure 4 suggest more specifically the lack of uniformity which caused the significant interaction. For both the on-campus technical students (Group II) and the metropolitan technical students (Group III), the results suggest that the Persuasive interests tended to increase as grade-point average increased. However, Figure 4 also illustrates that the

magnitude of increase is somewhat greater for Group III than for Group II which contributes to the interaction effects. For the on-campus engineering students a change in direction of increase is evident showing that Persuasive scores tended to decrease as grade-point average increased. The significant interaction results produced by this reversal in direction are illustrated quite clearly by the nearly perpendicular intersection of the lines for Groups II and III by the line for Group I.

TABLE XXV
MEAN KPR SCIENTIFIC SCORES FOR THREE
GROUPS AND TWO LEVELS OF
FRESHMAN STUDENTS

Level	Group I N=60	Group II N=90	Group III N=87	Total
Satisfactory Achievers	51.30	47.00	44.67	47.23
Low Achievers	42.30	45.66	47.96	45.82
Total	48.30	46.70	45.77	46.76

In summary, the significant interaction effects found for the EPPS Achievement scale and the Mechanical, Scientific and Persuasive scales of the KPR indicate that these measures are of little practical value in differentiating differences between the two achievement levels unless group membership is known. In this study it is apparent that the score on the response variable (EPPS Achievement scale and

KPR Mechanical, Scientific, and Persuasive scale) depends upon the combination of the other two variables (group membership and achievement level). However, an inspection of Figures 1, 2, 3, and 4 suggests some tentative inferences.

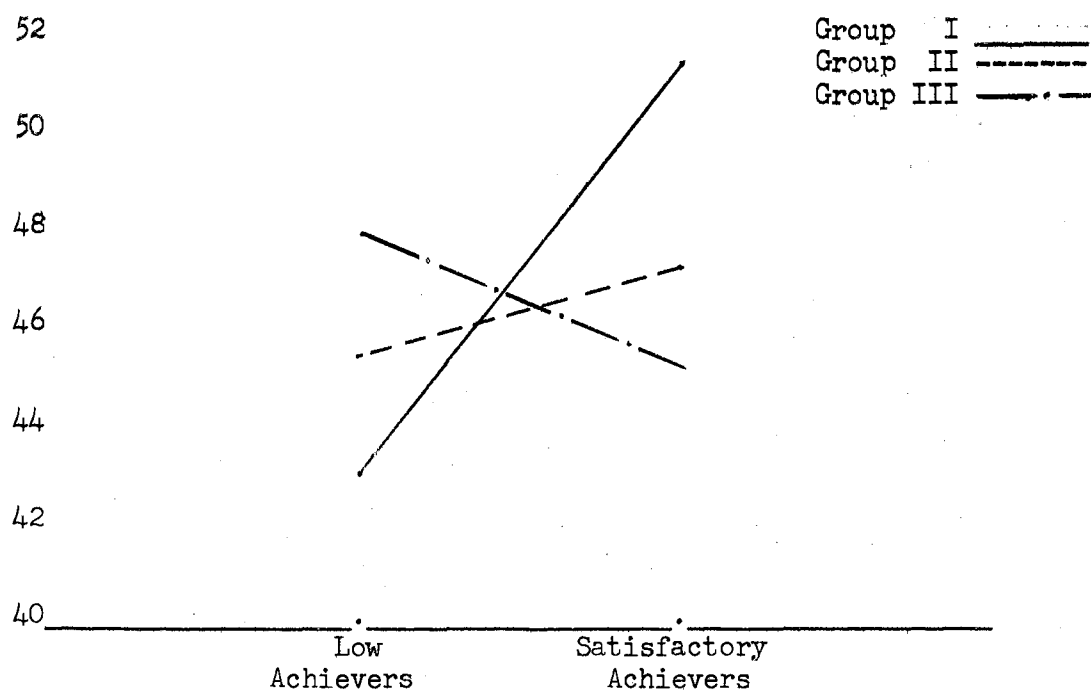


Figure 3. Illustration of Significant Interaction on the KPR Scientific Scale

TABLE XXVI

MEAN KPR PERSUASIVE SCORES FOR THREE GROUPS AND TWO LEVELS OF FRESHMAN STUDENTS

Levels	Group I N=60	Group II N=90	Group III N=87	Total
Satisfactory Achievers	35.42	37.10	36.70	36.51
Low Achievers	41.60	34.90	32.77	35.64
Total	37.45	36.21	35.40	36.22

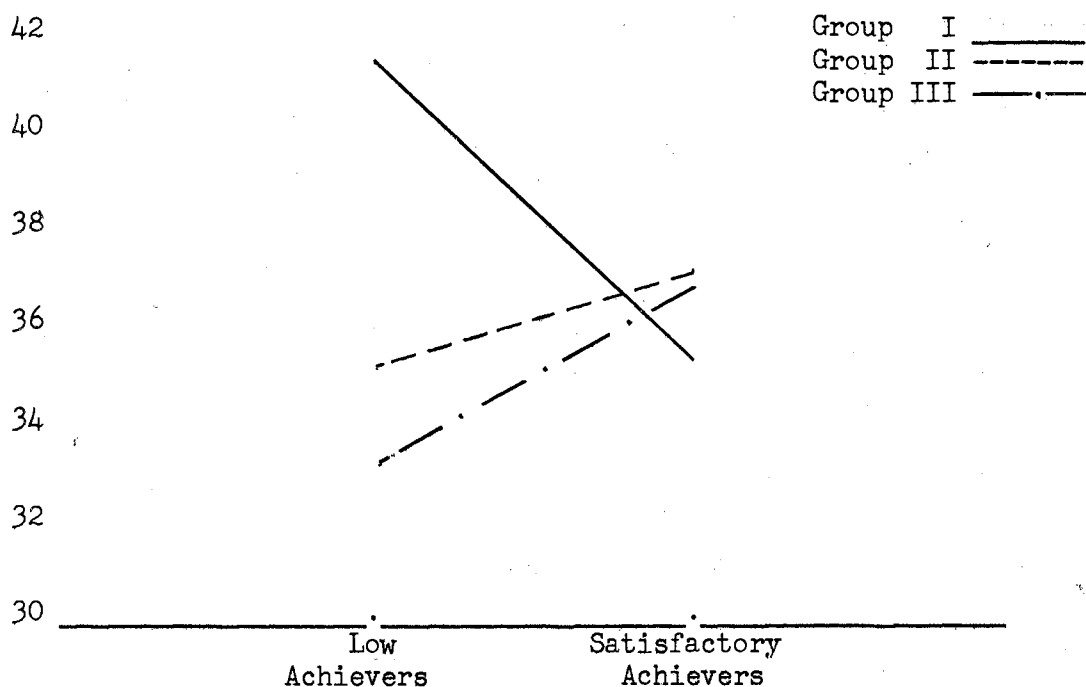


Figure 4. Illustration of Significant Interaction on the KPR Persuasive Scale

For the on-campus engineering group it appears that those students who received a satisfactory grade-point average, as compared to those who did not, tended to express a greater scientific interest; but a lesser interest in persuasive endeavors. This tentative interpretation pictures the satisfactorily achieving engineering student as indicating a preference or orientation toward discovering new facts and dealing with scientific problems over meeting and dealing with people.

For the on-campus technical institute group it appears that those students who achieved a satisfactory grade-point average, as compared to those who did not, tended to express greater mechanical, scientific and persuasive interests, but a lesser need for academic

achievement as measured by the EPPS. This tentative interpretation pictures the satisfactorily achieving on-campus technical institute student as expressing a relatively greater preference for working with tools and machines, solving scientific problems, and helping others, but expressing a lesser need for accomplishing academic tasks requiring skill and effort.

For the metropolitan technical institute group it appears that those students who achieved a satisfactory grade-point average, as compared to those who did not, tended to express a greater need for achievement and greater persuasive interests, but lesser scientific interest. This interpretation pictures the satisfactorily achieving metropolitan technical institute student as expressing a relative greater need to accomplish difficult tasks and a greater preference for working with and dealing with people, but a relatively lesser interest in solving scientific problems and working with machines and tools than the low achieving students.

Summary of Differences Between Satisfactorily Achieving and Low Achieving Students

The satisfactorily achieving and low achieving students can be compared with respect to ability, personality, and interest by examining Tables XX and XXI, and Figures 1, 2, 3, and 4. As shown in Table XX, the analysis of each of the measures of intellectual characteristics resulted in a significant F value. The implications of these results are that scholastic aptitude, mathematical skills reading skills, and mechanical comprehension are of the utmost importance in making satisfactory progress in the first semester of the

engineering and technical institute programs.

Significant differences were also found to exist on certain scales between satisfactorily achieving and low achieving students on the EPPS and the KPR. In comparison with the low achieving students, the satisfactorily achieving students had significantly higher dominance needs and computational interests and significantly lower nurturance needs and social service interests.

Further differences were found to exist between the satisfactorily achieving and low achieving students on the Achievement scale of the EPPS and the Mechanical, Scientific and Persuasive scales of the KPR. However, the relationships of scores on these scales to grade-point average varied greatly from group to group. The results of the analysis for these four scales were discussed in detail on pages 69 through 77 of this report.

Relationships Between Measured Characteristics and Academic Achievement

Since significant differences were found to exist between the three groups on several of the measured characteristics, each of the groups was studied separately in the correlation analysis. For each test score, a product-moment correlation coefficient was calculated to determine the relationship between first semester grade-point average (the criterion) and the measured characteristics. The various test scores of the predictor category were considered to be significantly correlated with the criterion category if the obtained r value equaled or exceeded the tabled value at the .05 level of probability for the appropriate degrees of freedom. Both positive and inverse

relationships were considered.

One further step in the research for each group was to perform a multiple regression analysis in order that the weights for the variables most highly correlated with the criterion could be selected for inclusion in a multiple regression equation.

The regression technique selected is referred to as a stepwise multiple linear regression. This analysis was performed on the IBM 7040 computer at the Oklahoma State University Statistical Laboratory. The computer was programmed for one dependent variable (first semester grade-point average) and twenty-nine predictor variables (scores on the ACT, CAT, BMC, NDRT, EPPS, and KPR).

In the stepwise regression procedure one variable at a time is entered into the regression equation; the potential variance reduction is considered for all the remaining variables and the variable which reduces the variance the most in a single iteration is selected. When the residual variance approaches zero and the degrees of freedom approach zero then any variables which have not been accounted for are considered to be of minimum importance; they may also be considered as measuring characteristics similar to the other variables which have already brought a reduction in the possible variance.

With the stepwise technique, intermediate results are used to give useful statistical information at each step in the calculation. A number of intermediate regression equations are obtained by adding one variable at a time, thus giving the following intermediate equations:

a. $Y = C + A_1 X_1$

b. $Y = C + A_1 X_1 + A_2 X_2$

$$c. Y = C + A_1 X_1 + A_2 X_2 + A_3 X_3, \text{ etc.}$$

The coefficients for each of these intermediate equations and the reliability of each coefficient are obtained step-by-step. The values and reliability may vary with each subsequent equation. The coefficients represent optimum values when the equation is fitted by the specific variables included in the equation. For the purposes of the present research, the variables included in the reported regression equation for each group were limited to those with a sequential F ratio for additional variance reduction that was significant at the .05 level of confidence.

Thus, the stepwise procedure is particularly useful because it selects the most important variable to the criterion in light of the other variables. Efroymson (15) has described the procedure mathematically and Draper and Smith (11) have provided a detailed computational method for stepwise regression analysis.

Results of the Analysis for Group I

Group I consisted of sixty subjects randomly selected from the total population of on-campus engineering freshmen. Correlations were computed between each test and the criterion (grade-point average) as well as between each of the tests. For testing the null hypothesis of no significant relationship, the various test scores were considered to be significantly correlated with the criterion if the obtained r value equaled or exceeded the tabled value at the .05 level of probability for the appropriate degrees of freedom. The null hypothesis was rejected for the ACT, CAT, BMC, NDRT, EPPS Achievement, EPPS Nurturance, KPR Computational, and the KPR Scientific. The means, correlation coefficients, and standard deviations of each of

these measures are provided in Table XXVII. All the correlations between the tests and the criterion and all the test intercorrelations are given in Table XXVIII.

TABLE XXVII
STATISTICALLY SIGNIFICANT CORRELATION
COEFFICIENTS WITH THE CRITERION
GROUP I (N=60)

Test	Mean	SD	Correlation Coefficient
ACT Composite	24.45	4.16	.74**
Coop. Alg. Test	30.61	8.20	.67**
Bennett Mech. Comp.	38.31	9.34	.36**
Nelson-Denny Reading	89.88	22.38	.63**
EPPS Achievement	25.98	3.17	.41**
EPPS Nurturance	12.91	5.00	-.27*
KPR Computational	32.76	7.13	.36**
KPR Scientific	48.03	3.85	.36**

* Significant at the 5% confidence level

** Significant at the 1% confidence level

TABLE XXVIII

THE INTERCORRELATION MATRIX OF THE SCORES ON THE ACT, CAT, BMC, NDRT, EPPS, KPR, AND GRADE-POINT AVERAGE
Group I (N=60).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. ACT Composite		67	64	79	21	-11	-13	14	06	02	-03	-12	17	-08	-22
2. CAT			40	57	16	-24	-10	05	10	14	-02	-14	22	-07	-20
3. BMC				47	08	-19	-12	17	15	02	05	-04	-09	11	-14
4. NDRT					20	-03	00	-11	02	05	06	-13	06	06	-05
5. EPPS Ach.						17	01	20	-19	-07	-01	-28	16	-11	-27
6. EPPS Def.							12	-11	-34	-19	-13	-11	03	23	00
7. EPPS Ord.								-13	-23	-15	-10	-09	-20	10	-10
8. EPPS Exh.									-16	-08	-27	08	27	-25	-28
9. EPPS Aut.										-20	-07	-16	00	-15	-14
10. EPPS AFF.											-07	05	-06	-03	41
11. EPPS Int.												-12	03	03	11
12. EPPS Succ.													-26	10	19
13. EPPS Dom.														-38	-37
14. EPPS Aba.															26
15. EPPS Nur.															
16. EPPS Chg.															
17. EPPS End.															
18. EPPS Het.															
19. EPPS Agg.															
20. KPR Outdoor															
21. KPR Mechanical															
22. KPR Computational															
23. KPR Scientific															
24. KPR Persuasive															
25. KPR Artistic															
26. KPR Literary															
27. KPR Musical															
28. KPR Social Service															
29. KPR Clerical															
30. Grade-Point Average															

TABLE XXVIII (cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. ACT Composite	-15	05	29	05	06	-02	35	39	-29	-31	13	21	-04	-16	74
2. CAT	-06	04	16	19	-08	01	34	21	-12	-11	-03	10	-05	-15	67
3. BMC	-19	02	33	-03	15	13	07	33	-24	-28	06	14	06	-22	36
4. NDRJ	-17	09	14	-06	13	-06	29	33	-32	-23	-25	-14	-06	-11	63
5. EPPS Ach.	-06	29	-20	-10	13	08	27	27	-36	04	10	-15	-13	-16	41
6. EPPS Def.	-15	17	-15	-42	05	02	-06	08	-16	02	08	00	-03	07	-06
7. EPPS Ord.	01	21	-10	-07	05	08	11	01	-06	20	-28	-34	-12	28	-09
8. EPPS Exh.	-16	-03	33	15	01	07	10	01	03	-23	-06	-03	17	-09	00
9. EPPS Aut.	18	06	-03	29	10	06	-04	00	-11	03	08	09	-27	04	-02
10. EPPS Aff.	-07	-28	-16	-02	-06	-23	-08	-17	17	-06	-05	12	34	-17	04
11. EPPS Int.	18	04	-26	-20	-26	-21	03	14	14	-10	03	07	06	00	10
12. EPPS Succ.	10	-46	15	-05	-11	-12	08	-20	11	10	01	20	10	04	19
13. EPPS Dom.	-11	01	10	29	-31	-08	26	12	01	-04	07	-13	03	-02	13
14. EPPS Aba.	-21	-11	-13	-36	10	09	-22	29	-12	-09	10	04	-07	-16	00
15. EPPS Nur.	-01	-23	-30	-22	-03	-06	-31	-19	11	09	-05	05	26	07	-27
16. EPPS Chg.		-09	03	09	-15	05	00	-39	06	41	-11	14	-21	27	-05
17. EPPS End.			-21	-06	08	19	04	17	04	00	00	-01	-12	05	07
18. EPPS Het.				10	05	22	07	-09	-07	-14	02	17	01	-18	03
19. EPPS Agg.					-01	08	03	-07	17	17	-27	-20	-05	11	02
20. RPR Outdoor						18	-24	21	-26	-15	-06	-19	00	-24	01
21. KPR Mechanical							-25	-02	-44	30	-23	-29	-28	-04	05
22. KPR Computational								37	-20	-33	15	-01	-19	40	36
23. KPR Scientific									-27	-48	07	-10	-16	-10	36
24. KPR Persuasive										-13	-30	02	40	-01	-21
25. KPR Artistic											-17	-13	-17	-14	-12
26. KPR Literary												19	-37	-08	06
27. KPR Musical													-16	-12	08
28. KPR Social Service														-28	-11
29. KPR Clerical															-10
30. Grade-Point Average															

(all decimals omitted)

From an inspection of Table XXVII it is apparent that all of the measures of intellectual characteristics yielded significant results. The ACT Composite, a measure of general scholastic aptitude, has the largest relationship with grade-point average received at the end of the first semester in engineering school. The second highest r was obtained for the CAT, a measure of understanding of basic algebra; the third highest r was obtained for the NDRT, a measure of reading vocabulary and reading comprehension. Of the four ability measures, the BMC, a test of understanding of physical and mechanical relationships, has the poorest relationship to grade-point average. The intercorrelations of these four tests (Table XXVIII) range from .40 to .79 which suggests that all are apparently measuring the same or very closely related traits or factors. Since a heavy emphasis is placed upon basic sciences, mathematics, and English during the first semester of engineering, and instruction in the specific applied areas is reserved for the upper division, these observed relationships for the aptitude and achievement tests appear congruent with expected results.

Only four of the twenty-five personality and interest variables were significantly related to the criterion.

The EPPS Achievement scale has an r of .41 with grade-point average, which is higher than the r obtained for one of the aptitude tests, the BMC. The r of -.27 obtained for the EPPS Nurturance scale indicates that scores on this measure are inversely related to the criterion. These findings suggest that higher motivation to be successful and to accomplish tasks requiring skill and effort is positively related to successful achievement in the first semester of engineering while higher motivation to be helpful and sympathetic to

others is associated with unsuccessful performance. Further interesting findings for these two scales are the relative low correlations of these measures with the measures of aptitude and achievement.

Table XXVIII reveals that the r 's for the Achievement scale with the ability and achievement tests range from .08 to .21 and the intercorrelations with the Nurturance scale range from -.05 to -.22. These intercorrelation coefficients suggest that the EPPS Achievement scale and the EPPS Nurturance scale are measuring characteristics or factors which are relatively independent of intellectual factors.

Both the Computational scale and the Scientific scale of the KPR were found to have an r of .36 with first semester grade-point averages. These results indicate that relatively greater interest in working with numbers and in discovering new facts and solving problems is positively related to successful achievement in the first semester of engineering. The intercorrelations of the two significant interest scales with the measures of aptitude and achievement were somewhat larger than were those of the two significant personality scales. The intercorrelations of the Computational scale with the aptitude and achievement tests range from .07 to .35 and the intercorrelations of the Scientific scale range from .21 to .39.

Since composite measures representing different aspects of behavior are usually more useful for guidance than are individual assessments, one further step in the research for Group I was to perform a stepwise multiple regression analysis in order that the weights for the variables most highly correlated with the criterion could be selected for use in a multiple regression equation. The composite measure is based upon the three variables that resulted in

significant sequential F values when entered into the regression equation in a stepwise fashion. The sequential F-test was made for each regression coefficient to evaluate the relative effects of each predictor variable in excess of the others.

Table XXIX shows the results for Group I of steps 1, 2, and 3 for entering a variable in the regression equation in a stepwise fashion. The first variable to enter the equation was the composite score of the ACT. The F value is 70.11 and is significant at the .01 level. The second variable to enter the equation was the EPPS Achievement scale. The F value is 9.86 and is significant at the .01 level. The third variable to enter was the CAT which resulted in an F value of 8.61 which is also significant at the .01 level. When the remaining variables were added one by one to the regression equation, none resulted in an F value for additional variance reduction that was significant at the .05 level of confidence.

Thus, the multiple regression equation for Group I was found to be as follows:

$$Y = .09937 X_1 + .06962 X_2 + .03175 X_3 - (-2.22309)$$

where

X_1 is the ACT Composite score

X_2 is the EPPS Achievement score

X_3 is the ACT score.

The multiple R was found to be .82 which implies that approximately sixty-seven per cent of the variability in the criterion was accounted for by three predictors combined in the equation.

Results of the Analysis for Group II

Group II consisted of ninety on-campus technical institute

TABLE XXIX
RESULTS OF STEPS 1, 2, AND 3 FOR ENTERING A VARIABLE INTO THE
REGRESSION EQUATION IN A STEPWISE FASHION
Group I (N=60)

Entering Variable	F	Standard Error of Y	Constant	Variables in Regression Equation	Coefficient of Variables in Regression Equation	Standard Error of Coefficient	Multiple Correlation Coefficient
ACT Composite	70.11**	.5857	-1.42874	ACT Composite	.15215	.01817	.74
EPPS Achievement	9.86**	.5452	-2.29432	ACT Composite	.14084	.01730	.78
				EPPS Achievement	.07146	.02275	
CAT	8.61**	.5123	-2.22309	ACT Composite	.09937	.02154	.82
				EPPS Achievement	.06962	.02138	
				CAT	.03175	.01082	

** Significant at the 1% confidence level

freshmen. Correlations were computed between each test and the criterion as well as between each of the tests. For testing the null hypothesis of no significant association, the various test scores were considered to be significantly correlated with the criterion if the obtained r value equaled or exceeded the tabled value at the .05 level of probability for the appropriate degrees of freedom. The null hypothesis was rejected for the ACT, CAT, EMC, NDRT and the Autonomy scale of the EPPS. The means, correlation coefficients, and standard deviations of each of these measures are provided in Table XXX.

TABLE XXX
STATISTICALLY SIGNIFICANT CORRELATION
COEFFICIENTS WITH THE CRITERION
GROUP II (N=90)

Test	Mean	S. D.	Correlation Coefficient
ACT Composite	18.78	4.42	.51**
Cooperative Algebra	23.44	9.05	.52**
Bennett Mech. Comp.	32.78	7.42	.42**
Nelson-Denny Reading	66.55	19.73	.35**
EPPS Autonomy	13.73	4.60	.22*

* Significant at the 5% confidence level

** Significant at the 1% confidence level

All the correlations between the tests and the criterion and all

intercorrelations are given in Table XXXI.

Inspection of Table XXX indicates that the analysis of each aptitude and achievement measure resulted in significant outcomes. The tests with the highest relationship with grade-point average were the CAT, with an r of .52, and the ACT Composite, with an r of .51. An r of .42 was obtained for the BMC which was the third highest coefficient obtained. Of the measures of intellectual characteristics the NDRT has the poorest relationship with grade-point average earned at the end of the first semester of training in the on-campus technical institute.

It appears that general scholastic aptitude, understanding of basic algebra concepts and skills, and capacity for understanding physical and mechanical relationships are positively related to successful performance in the first semester of course work in the on-campus technical institute. Reading vocabulary and comprehension is also positively related but to a lesser degree. The intercorrelations of the four aptitude and achievement tests range from .37 to .68 (Table XXXI).

The validity coefficients for the scholastic aptitude, mathematics, and mechanical comprehension measures imply that these tests are relatively sensitive to the instructional and evaluation methods used in the on-campus technical institute. While the engineering technology programs include both didactic and laboratory instructional methods, the laboratory instructional method is used with frequency and emphasis is placed upon the practical application of basic mathematical and scientific concepts to technical problems.

Only one of the twenty-five personality and interest variables

TABLE XXXI

THE INTERCORRELATION MATRIX OF THE SCORES ON THE ACT, CAT, BMC, NDRT, EPPS, KPR, AND GRADE-POINT AVERAGE
GROUP II (N=90)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. ACT Composite		68	47	75	14	-07	-10	11	21	05	-01	04	19	05	-16
2. CAT			38	47	06	-02	-06	07	08	02	01	15	08	13	-03
3. BMC				37	11	-04	03	06	18	-09	00	-02	13	-04	-19
4. NDRT					20	47	-19	22	18	15	-03	-15	22	-07	00
5. EPPS Ach.						-11	06	-03	18	-12	00	00	-04	-28	-21
6. EPPS Def.							32	03	-25	03	12	-11	00	05	10
7. EPPS Ord.								-08	-29	-30	04	04	-12	-11	-12
8. EPPS Exh.									-09	-02	-16	02	17	-03	14
9. EPPS Aut.										-38	-14	-04	-12	-20	-10
10. EPPS AFF.											-13	03	06	04	44
11. EPPS Int.												-26	-02	-04	-16
12. EPPS Succ.													-19	-08	14
13. EPPS Dom.														-31	-15
14. EPPS Aba.															15
15. EPPS Nur.															
16. EPPS Chg.															
17. EPPS Erd.															
18. EPPS Het.															
19. EPPS Agg.															
20. KPR Outdoor															
21. KPR Mechanical															
22. KPR Computational															
23. KPR Scientific															
24. KPR Persuasive															
25. KPR Artistic															
26. KPR Literary															
27. KPR Musical															
28. KPR Social Service															
29. KPR Clerical															
30. Grade Point Average															

TABLE XXXI (Cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. Act Composite	01	-29	03	00	02	10	03	12	-06	-05	06	10	-11	-05	51
2. CAT	-01	-14	-07	04	00	13	20	02	-03	-10	00	-08	-08	04	52
3. EWC	13	-29	09	04	10	06	05	20	-03	-03	02	16	-25	-15	42
4. NDRT	18	-35	05	-08	-08	-02	-13	04	-02	-06	25	23	-10	-17	35
5. EPPS Ach.	11	-06	-11	-24	-07	00	05	20	03	-10	13	08	-18	-06	00
6. EPPS Def.	16	13	-39	-33	-07	21	-11	-07	-03	-05	-27	-13	17	17	05
7. EIPS Ord.	-10	26	-14	-24	15	16	-04	19	-12	-10	-11	-09	-04	23	08
8. EIPS Exh.	04	-13	-19	-07	-05	-10	-24	02	00	15	02	06	12	-20	-10
9. EIPS Aut.	24	-14	00	29	-13	09	07	20	-02	10	-05	15	-16	-15	22
10. EIPS Aff.	-08	-30	-01	-14	08	-15	-02	-09	-02	-19	14	04	06	00	-13
11. EIPS Int.	-30	21	-13	-28	-13	-08	13	00	-05	-20	15	04	10	13	-01
12. EPPS Succ.	00	-22	-08	01	15	-01	01	06	-06	17	-12	-23	-21	10	-04
13. EPPS Dom.	01	-13	-01	21	-02	-11	-10	-02	-16	-07	07	11	07	01	16
14. EPPS Aba.	-24	-06	-15	-03	05	13	06	-09	-12	05	-21	-12	26	02	-04
15. EPPS Nur.	-17	-17	-21	-13	05	02	-22	-15	01	00	-10	-13	29	00	-19
16. EPPS Chg.		-20	06	-03	-06	04	-22	-08	14	18	08	33	-33	-25	-03
17. EPPS End.			-16	-13	04	03	19	-05	-03	-09	-06	-21	17	14	05
18. EPPS Het.				10	01	-08	09	-03	18	04	13	12	-19	-13	01
19. EPPS Agg.					02	01	04	-07	01	15	02	-11	-03	01	13
20. KPR Outdoor						22	-14	14	-49	-10	-03	-28	10	-31	02
21. KPR Mechanical							-17	08	-19	01	-56	-44	21	-18	15
22. KPR Computational								28	-17	-17	-01	-30	-16	45	10
23. KPR Scientific									-41	-24	-05	-04	-09	03	-03
24. KPR Persuasive										07	-07	21	-17	02	04
25. KPR Artistic											-19	-10	-29	-02	-06
26. KPR Literary												35	-21	-02	-13
27. KPR Musical													-22	-07	-11
28. KPR Social Service														-34	-08
29. KPR Clerical															02
30. Grade Point Average															

(all decimals omitted)

was significantly related to the criterion. The EPPS Autonomy scale had an r of .22 with grade-point average which is significant at the .05 level. This finding suggests that relative higher motivation to be independent of others in making decisions and to be able to do things without regard to what others may think is positively related to successful achievement in the on-campus engineering technology programs. As shown in Table XXXI, the intercorrelations of the EPPS Autonomy scale with the aptitude and achievement tests range from .08 to .21.

One further step in the research for Group II was to perform a stepwise multiple regression analysis in order that the weights for the variables most highly correlated with the criterion could be selected for use in a multiple regression equation. The four variables selected were those that resulted in significant sequential F values when entered into the regression equation in a stepwise fashion. The sequential F -test was made for each regression coefficient in order to evaluate the relative effects of each predictor variable added to the regression equation.

Table XXXII summarizes the results for Group II of steps 1, 2, 3, and 4 for entering a variable into the regression equation in a stepwise manner. The first variable to enter the equation was the CAT with an F value of 31.97 which is significant at the .01 level of confidence. The second variable to enter the equation was the NDRT with an F value of 7.43 which is significant at the .01 level. The third variable to enter was the EPPS Endurance scale with an F value of 4.79 and the fourth to enter was the ACT Composite with an F value of 5.08. The F ratios for additional variance reduction for the EPPS

TABLE XXXII
RESULTS OF STEPS 1, 2, 3, and 4 FOR ENTERING A VARIABLE INTO THE
REGRESSION EQUATION IN A STEPWISE FASHION
Group II (N=90)

Entering Variable	F	Standard Error of Y	Constant	Variables in Regression Equation	Coefficient of Variables in Regression Equation	Standard Error of Coefficient	Multiple Correlation Coefficient
CAT	31.97**	.7960	1.03133	CAT	.05242	.00927	.52
NDRT	7.43**	.7685	.21316	CAT NDRT	.04235 .03215	.00968 .01180	.57
EPPS Endurance	4.79*	.7523	-.53974	CAT NDRT EPPS Endurance	.04301 .03904 .03505	.00948 .01198 .01601	.60
ACT Composite	5.08*	.7350	-1.11208	CAT NDRT EPPS Endurance ACT Composite	.05822 .02643 .03179 .04222	.02584 .01183 .01214 .01597	.63

* Significant at the 5% confidence level

**Significant at the 1% confidence level

Endurance scale and the ACT Composite are significant at the .05 level of confidence. When the remaining variables were added one by one to the regression equation, none resulted in a significant F value for additional reduction in criterion variance. The multiple regression equation for Group II was thus found to be as follows:

$$Y = .05822 X_1 + .02643 X_2 + .03179 X_3 + .04222 X_4 - (-1.11208)$$

where

X_1 is the CAT score

X_2 is the NDRT score

X_3 is the EPPS Endurance score

X_4 is the ACT Composite score.

The multiple R was found to be .63 which implies that approximately forty per cent of the variability in the criterion was accounted for by the four predictors combined in the regression equation.

Results of the Analysis for Group III

Group III consisted of eighty-seven metropolitan technical institute freshmen. Correlations were computed between each test and the criterion (grade-point average) as well as between each of the tests. For testing the null hypothesis of no significant relationship, the various test scores were considered to be significantly correlated with the criterion if the obtained r value equaled or exceeded the tabled value at the .05 level of probability and appropriate degrees of freedom. The null hypothesis was rejected for the aptitude and achievement tests, the Achievement, Change, and Endurance scales of the EPPS, and the KPR Computational scale. The means, correlation coefficients, and standard deviations for each of these measures are presented in Table XXXIII. All of the correlations

between the tests and the criterion and all the test intercorrelations are given in Table XXXIV.

TABLE XXXIII
STATISTICALLY SIGNIFICANT CORRELATION
COEFFICIENTS WITH THE CRITERION
Group III (N=87)

Test	Mean	S.D.	Correlation Coefficient
ACT Composite	16.52	4.78	.47**
Cooperative Algebra	21.28	12.48	.21*
Bennett Mech. Comp.	29.10	7.41	.21*
Nelson-Denny Reading	63.09	20.80	.35**
EPPS Achievement	14.41	3.85	.27**
EPPS Change	15.94	4.36	-.22*
EPPS Endurance	15.36	4.61	.22*
KPR Computational	33.17	7.61	.27**

* Significant at the 5% confidence level

** Significant at the 1% confidence level

Inspection of Table XXXIII indicates that the analysis of each of the aptitude and achievement tests resulted in a significant coefficient. The ACT Composite, with an r of .47, has the highest relationship with grade-point average earned at the end of the first semester of training in the metropolitan technical institute.

TABLE XXXIV

THE INTERCORRELATION MATRIX OF THE SCORES ON THE ACT, CAT, BMC, NDRT, KPR, AND GRADE-POINT AVERAGE
GROUP III (N=87)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. ACT Composite		66	43	73	38	-03	-20	19	-25	-15	-03	09	18	10	-06
2. CAT			23	45	15	-18	-28	24	-08	08	-20	26	-10	25	06
3. BMC				34	18	-05	03	07	-09	-08	03	-07	21	-07	-09
4. NDRT					46	-08	-07	02	-32	-18	-01	05	17	00	-14
5. EPPS Ach.						14	05	04	-17	-38	09	-38	37	-35	-36
6. EPPS Def.							22	-19	-22	-16	36	-27	03	-08	11
7. EPPS Ord.								-09	02	-28	-12	-24	02	-23	-16
8. EPPS Exh.									02	-07	-22	06	06	-07	-16
9. EPPS Aut.										-24	-02	-21	-06	-06	-27
10. EPPS Aff.											-11	32	-28	11	40
11. EPPS Int.												-39	13	09	01
12. EPPS Succ.													-38	16	34
13. EPPS Dom.														-42	-36
14. EPPS Aba.															21
15. EPPS Nur.															
16. Epps Chg.															
17. EPPS End.															
18. EPPS Het.															
19. EPPS Agg.															
20. KPR Outdoor															
21. KPR Mechanical															
22. KPR Computational															
23. KPR Scientific															
24. KPR Persuasive															
25. KPR Artistic															
26. KPR Literary															
27. KPR Musical															
28. KPR Social Service															
29. KPR Clerical															
30. Grade Point Average															

TABLE XXXIV (cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. ACT Composite	-14	06	02	-14	01	02	08	25	-14	05	02	-02	-17	-03	47
2. CAT	05	-24	15	-12	04	00	01	10	-09	09	-14	-01	-15	01	21
3. EMC	-11	-07	02	02	09	13	-14	16	-03	06	-09	02	07	-23	21
4. NDRT	03	-04	09	-10	08	08	00	19	-26	-01	-02	-08	-03	-01	35
5. EPPS Ach.	-26	26	-02	-11	-04	04	20	32	07	-03	02	-22	-16	-11	27
6. EPPS Def.	-38	36	-40	-24	22	-04	23	25	-16	-37	35	-11	05	-15	09
7. EPPS Ord.	-06	24	-23	-10	06	01	06	02	-15	09	06	-06	06	-14	-05
8. EPPS Exh.	06	-12	-03	-22	-27	-05	-04	-08	12	12	-24	23	-06	25	-03
9. EPPS Aut.	29	05	-21	24	09	05	-15	-08	02	12	-15	10	-12	-01	-03
10. EPPS Aff.	-01	-31	16	-19	14	-19	-03	-26	08	03	04	05	09	02	-17
11. EPPS Int.	-15	17	-50	-18	10	-11	-08	-01	-09	-05	22	02	09	-10	13
12. EPPS Succ.	-01	-45	33	-03	-08	00	-10	-15	01	08	-14	13	05	14	-05
13. EPPS Dom.	-24	14	-19	14	-11	-09	25	20	14	-11	12	-09	-01	-09	12
14. EPPS Aba.	17	-20	-14	00	-06	11	-12	-12	-03	-10	-06	15	12	11	03
15. EPPS Nur.	-16	-14	-10	-24	15	02	-08	-14	-08	-08	00	-04	11	-10	-17
16. EPPS Chg.		-31	03	02	02	12	-29	-05	-08	16	-32	07	-03	16	-22
17. Epps End.			-31	-21	18	13	18	20	-10	-07	13	-18	-15	-14	22
18. EPPS Het.				15	-22	-10	-05	-13	15	17	02	03	-06	15	-06
19. EPPS AGG.					-07	14	14	09	-05	-10	-02	-07	-07	04	01
20. KPR Outdoor						32	-16	40	-41	-13	-13	-30	-10	-47	-14
21. KPR Mechanical							-20	30	-17	-03	-54	-23	-32	-32	-12
22. KPR Computational								20	-05	-37	36	-26	-10	35	27
23. KPR Scientific									-28	-33	02	-30	-20	-37	05
24. KPR Persuasive										-05	-04	-04	-14	13	08
25. KPR Artistic											-31	14	-24	-01	-13
26. KPR Literary												07	10	-04	12
27. KPR Musical													11	-05	-19
28. KPR Social Service														-07	-06
29. KPR Clerical															18
30. Grade Point Average															

(all decimals omitted)

An r of .35 was obtained for the NDRT which was second highest. Both the CAT and BMC had rather low correlations (r of .21) with first semester grade-point average.

Thus, it appears that general scholastic aptitude and reading vocabulary and comprehension have the strongest relationship to successful performance in the metropolitan technical institute. Understanding of basic algebra concepts and skills and capacity for understanding of physical and mechanical relationships are also positively related, but to a lesser degree. The rather low correlations between mathematical skills and success and mechanical comprehension and success are somewhat surprising in light of the metropolitan institute curriculums and instructional methods. As in the case of the on-campus technical institute, each of the metropolitan institute curriculums consists of about sixty-four per cent specialized technical courses and about fifteen per cent mathematics (43). Also, as in the on-campus institute, the laboratory method is used extensively and emphasis is placed upon the practical application of basic mathematics and scientific skills and concepts to technical problems. Due to similarities in curriculum objectives and methods, the various measures of intellectual characteristics had been expected to function at about the same level of effectiveness at both institutions.

The differences in validity coefficients found for the two technical institute groups on the BMC and the CAT might be tentatively explained by referring to the differences found between the two groups in chronological age and in measured abilities. The metropolitan institute students are older, have been out of high school

longer, and are apparently somewhat less well prepared for college level course work. The instructional program at the metropolitan institute might reflect these differences through differing levels of beginning course content and student evaluation practices. However, this explanation of observed differences in validity coefficients is based only upon tentative inferences.

Four of the twenty-five personality and interest variables were found to be significantly related to the criterion. The intercorrelations of the personality and interest measures with the ability tests range from .00 to .46 (Table XXXIV).

The EPPS Achievement scale has an r of .27 with grade-point average, the EPPS Endurance an r of .22, and an r of $-.22$ was obtained for the EPPS Change scale.

The results indicate that higher motivation to be successful and to accomplish tasks requiring skill and effort and higher motivation to persevere on tasks undertaken are positively related to successful achievement. The r of $-.22$ obtained for the EPPS Change scale suggests that higher motivation to do new and different things is inversely related to successful performance.

The r of .27 found for the KPR Computational scale suggests that relatively higher interests in working with numbers is also associated with successful achievement in the metropolitan technical institute.

The next step in the research for Group III was to perform a stepwise multiple regression analysis in order that the best combination of predictor variables could be selected for use in a multiple regression equation. The two variables selected were those that

resulted in significant sequential F values when entered into the regression equation in a stepwise fashion. The sequential F-test was made for each regression coefficient in order to evaluate the relative effects of each predictor variable added to the regression equation.

Table XXXV shows the results of steps 1 and 2 for entering a variable into the regression equation in a stepwise procedure. The first variable to enter the equation was the ACT Composite, and the second variable to enter was the KPR Computational scale. The analysis of the ACT Composite scores resulted in an F of 24.23 which is significant at the .01 level of confidence, and the addition of the KPR Computational scores resulted in an F of 6.33 which is significant at the .05 level. When the remaining variables were added one by one to the regression equation, none resulted in a significant F value for additional reduction in criterion variance. The multiple regression equation for Group III was thus found to be as follows:

$$Y = .07554 X_1 + .02458 X_2 - .44148$$

where

X_1 is the ACT Composite score

X_2 is the KPR Computational score.

The multiple R was found to be .53 which implies that about twenty-eight per cent of the variability in the criterion was accounted for by the two predictors combined in the regression equation.

Summary of the Relationships Found Between
Measured Characteristics and Academic
Achievement

TABLE XXXV

RESULTS OF STEPS 1 AND 2 FOR ENTERING A VARIABLE INTO THE
REGRESSION EQUATION IN A STEPWISE FASHION
Group III (N=87)

Entering Variable	F	Standard Error of Y	Constant	Variables in Regression Equation	Coefficient of Variables in Regression Equation	Standard Error of Coefficient	Multiple Correlation Coefficient
ACT Composite	24.23**	.7128	1.20515	ACT Composite	.07867	.01598	.47
KPR Computational	6.33*	.6915	.44148	ACT Composite KPR Computational	.07554 .02458	.01555 .00977	.53

* Significant at the 5% confidence level

** Significant at the 1% confidence level

It appears that each of the aptitude and achievement tests has potential usefulness as a predictor of academic success in engineering and engineering technology. The ACT Composite consistently tended to be a good predictor in each group, while the effectiveness of the CAT, EMC, and NDRT varied greatly from group to group. In general, the tests were most efficient in predicting the success of the engineering students and least efficient in predicting the achievement of the engineering technology students.

Very few significant relationships were found between the personality variables as measured by the EPPS and academic achievement, and the EPPS scales with significant coefficients varied greatly from group to group. Only the Achievement scale had simple correlation coefficients that were significant in more than one group. However, due to the relatively low intercorrelations of these measures with the ability measures, the EPPS Achievement scale added significantly to the efficiency of the regression equation for Group I and the Endurance scale added significantly to variance reduction in the regression equation for Group II.

The results of this study suggest that vocational interests as measured by the KPR are of very limited practical usefulness in predicting academic success in engineering and engineering technology. The variance reduction due to the addition of a KPR interest scale was significant in only the regression equation for Group III.

The results of this study demonstrate that the usefulness of test data for forecasting academic performance should be established at each individual institution despite apparent similarities in curricular objectives and structure. Generalizations from institution to institution are hazardous.

CHAPTER V

SUMMARY AND CONCLUSION

General Summary of the Investigation

This investigation was concerned with three groups of freshmen male students who entered different educational institutions administered by the College of Engineering of Oklahoma State University. Group I consisted of 60 on-campus engineering students; Group II consisted of 90 on-campus technical institute students; and Group III consisted of 87 metropolitan technical institute students. The technical institute freshmen were beginning associate degree programs and the engineering freshmen were beginning baccalaureate degree programs.

The purposes of this investigation were (1) to examine the differences in certain measured intellectual and non-intellectual characteristics between on-campus engineering freshmen, on-campus technical institute freshmen, and metropolitan technical institute freshmen, (2) to determine if there are significant differences in the tested characteristics between satisfactorily achieving and low achieving engineering and engineering technology students, and (3) to study the relationships between the measured characteristics and achievement in the engineering and technical institute programs.

In this investigation four standardized tests were used for the purpose of measuring intellectual factors. The instruments used were

the American College Testing Battery, the Cooperative Algebra Test, the Nelson-Denny Reading Test, and the Owens-Bennett Test of Mechanical Comprehension. Two standardized inventories were used for the purpose of measuring non-intellective factors - the Kuder Preference Record and the Edwards Personal Preference Schedule.

The analysis of variance was used to test differences among the three groups, between the two achievement levels, and to determine the nature of the interaction effects. When significant F's were found, Duncan's new multiple-range test for groups with unequal replication was used to make comparisons between means. A coefficient of correlation was used to determine relationships between first semester grade-point average and each of the measured characteristics. Also, an application of multiple regression analysis, stepwise regression, was performed in order that the weights for the variables most highly correlated with the criterion could be determined for predicting the criterion.

Summary of Results

From the analysis of differences between the three groups it was found that the engineering students were superior to both groups of technician students in scholastic aptitude, algebra skills, reading skills, and mechanical comprehension. The on-campus technician students were superior to the metropolitan technician students in scholarship aptitude and in mechanical comprehension. Although the differences were not statistically significant, the on-campus technician students also tended to score higher on the algebra and reading tests.

Although the three groups were found to be quite homogeneous in personality characteristics as measured by the EPPS, the data did indicate that the engineering students manifested greater achievement needs while the technician students demonstrated greater order needs.

Several statistically significant differences were found among the three groups in vocational interests as measured by the KPR. Both groups of technician students expressed greater social service and outdoor interests than did the engineering students. When the differences between technician groups were examined, it was found that the on-campus technician students expressed greater mechanical and literary interests while the metropolitan technician students demonstrated greater computational interests. Despite the statistically significant differences found among the three groups in vocational interests, inspection of the data suggests that the magnitude and direction of the differences are such that they appear to be of limited practical usefulness.

The differences between satisfactorily achieving and low achieving engineering and engineering technology students were examined using the analysis of variance. The results indicate that the satisfactorily achieving students are superior in general scholastic aptitude, capacity for understanding physical and mechanical relationships, understanding of basic algebra, and reading vocabulary and comprehension.

Significant differences were also found to exist between satisfactorily achieving and low achieving students on the measures of non-intellective characteristics. The satisfactorily achieving students had significantly higher dominance needs and computational

interests and lower nurturance needs and social service interests than the low achieving students. Further differences were found to exist between satisfactorily achieving and low achieving students on the Achievement scale of the EPPS and the Mechanical, Scientific, and Persuasive scales of the KPR. However, the relationships of scores on these scales to grade-point average varied greatly from group to group.

It would appear, on the basis of the analysis of the 29 variables included in this study, that it is primarily in the realm of mental abilities that one can most consistently and meaningfully differentiate among the three groups and between those students receiving a satisfactory grade-point average at the end of the first semester and those failing to make satisfactory progress.

For each of the three groups, the relationships between the measured characteristics and academic achievement were examined using coefficients of correlation and multiple stepwise regression analysis. The ACT Composite consistently tended to be a good predictor in each group while the effectiveness of the CAT, BMC, and NDRT varied greatly from group to group. In general, the tests were most efficient in predicting the performance of the engineering students and least efficient in predicting the achievement of the engineering technology students.

Very few significant relationships were found between personality variables as measured by the EPPS and academic achievement, and the scales with significant coefficients varied from group to group. The EPPS Achievement scale added significantly to the efficiency of the regression equation for Group I and the Endurance scale added

significantly to reduction of criterion variance in the regression equation for Group II.

The results of this study indicate that vocational interests, as measured by the KPR, are of very limited practical usefulness in predicting academic performance in engineering and engineering technology.

Recommendations and Conclusion

The need for this study evolved, in part, from the need for further information concerning the characteristics of the type of student attending the technical institute and the factors leading to successful achievement in an institute program. Differences among engineering technology students have been identified in this study and the results clearly demonstrate that the usefulness of test data for predicting academic performance should be established at each individual institution despite apparent similarities in curricular level, objectives, and structure. The results suggest that college level technician education programs at different institutions serve students with different characteristics. It is recommended that student personnel workers and other educators responsible for planning an expanded program of technician education give careful consideration to the characteristics of students to be served. Research directed at investigating the relationship between institutional environment and student characteristics would appear pertinent.

In general, scores on measures of scholastic aptitude, mechanical comprehension, algebra skills, and reading skills appear to be related favorably to grade-point average earned in the first semester of engineering and engineering technology and it follows that elevation

of these scores would appear to magnify the probability of a student's chances of achieving satisfactorily. However, the results obtained in this study are based upon groups of subjects and generalizations to a single individual are hazardous.

While there is some evidence of statistical relationships between scores on some of the scales of the personality and interest tests and grade-point average achieved, the recommended use of these measures in this case is as a general aid for facilitating discussion of a client's preferences rather than as a predictive tool. A future study, similar to this investigation, might be further enhanced by isolating the intellectual factor and statistically holding that factor constant while further analyzing all non-intellectual factors.

Additional limitations in the use of the psychometric instruments are suggested in that results quoted are applied solely to the criterion sample in question and the efficiency with other groups would probably be lower. Research directed toward the cross-validation of these data would, hopefully, provide greater confidence in the outcomes. Additional research could examine the degree of deterioration of predictive power and could lead to the construction of tables of probability for estimating grade-point average.

In conclusion, the results of this investigation suggest that certain intellectual and non-intellectual factors and combination of factors are related to both selection and achievement in an engineering or technical institute program. It appears, on the basis of these data, that there would be some utility in using the instruments utilized in this investigation for counseling and advising students entering these kinds of programs. As for predictive

value, especially the prediction of performance of individual subjects, limitations should be exercised until further research, conducted with similar subjects, has been completed.

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